US Army
Corps of Engineers
Nashville District

Tennessee
Valley
Authority

US Fish and
Wildlife Service
Cookeville, TN

COOPERATING AGENCIES

CENTER HILL DAM AND LAKE
DEKALB COUNTY, TENNESSEE

CHANGES TO CENTER HILL LAKE ELEVATIONS

FINAL ENVIRONMENTAL IMPACT STATEMENT

US Army Corps of Engineers

November 2007

CENTER HILL DAM AND LAKE
DEKALB COUNTY, TENNESSEE

CHANGES TO OPERATIONAL GUIDE CURVES
POOL ELEVATIONS

DRAFT ENVIRONMENTAL IMPACT STATEMENT

Responsible Federal Agency:
U.S. Army Corps of Engineers

Cooperating Agency:
U.S. Fish and Wildlife Service
Tennessee Valley Authority

Alternatives:
(1) No Action – Maintain Existing Guide Curve and Pool Elevations.
(2) Operate Below the Guide Curve with Low Pool Elevations.

Location:
DeKalb County, Tennessee

Abstract:
Center Hill Dam is located in northern DeKalb County in central Tennessee. The dam is located on the Caney Fork River at Mile 26.6 (36^{O} 05' 51"N; 85^{O} 49' 35"W) a major tributary of the Cumberland River. The combination concrete and earthen embankment dam was designed & built in the 1930's through the 1940's. A saddle dam was constructed in 1946 to close a V-notch through the right rim. The entire Project was completed in 1951. The dam impounds the second largest flood control reservoir owned and operated by the U.S. Army Corps of Engineers, Nashville District (Corps). The three-generator unit hydroelectric plant located immediately downstream on the left descending bank of the Caney Fork River has a total capacity of 135,000 kilowatts (kw). The average discharge from the dam is approximately 3,800 cubic feet per second. Center Hill Lake has a drainage area of 2,174 square miles and a surface area of 18,220 acres. The lake impounds 2,092,000 acre-feet at its maximum flood control pool elevation (EL, National Geodetic Vertical Datum of 1929, commonly referred to as feet above mean sea level) EL 685. The average depth is 73 feet and the retention time is about 130 days. The concrete dam, earthen embankment, saddle dam, left and right rims have been plagued with increasing seepage problems since construction of the dam. Two Environmental Assessments were completed in 2006 to address seepage repairs and Findings of No Significant Impact were executed for each. At that time, no significant changes to the customary pool elevations were considered necessary. However, these repairs will take a number of years to implement. As a proactive measure, the Corps is evaluating different interim lake elevations that would reduce hydrostatic pressure and balance the risk of dam failure with the impact to project purposes and environmental resources. The purpose of this Draft Environmental Impact Statement is to cover possible impacts due to interim pool elevations including extreme elevation changes that could occur during the 7-year repairs of the dam's foundation and abutments.

Review comments must be received no later than December 10, 2007.

For additional information or to send review comments, contact: Ms. Joy Broach, Project Planning Branch, U.S. Army Corps of Engineers, P.O. Box 1070, Nashville, Tennessee 37202-1070, (615) 736-7956. An electronic copy of the DEIS can be found at http://www.lrn.usace.army.mil/CenterHill, and comments may be e-mailed to: CenterHill.Repair@lrn02.usace.army.mil.

SUMMARY

The U.S. Army Corps of Engineers, Nashville District (Corps) operates Center Hill Dam and Lake. Center Hill Dam is located at Mile 26.6 on the Caney Fork River in DeKalb County, Tennessee. The Caney Fork is a major tributary to the Cumberland River. The Center Hill project has been in service for 56 years (1951-2007) providing important benefits of flood control, hydropower, recreation, water supply, water quality, fish and wildlife. The dam is 250 feet high and consists of a 1,382 foot long concrete section and a 778 foot long rolled earth embankment. A 770 foot long earthen saddle dam is located in the right descending rim. A three-generator-unit power plant, with a capacity of 135,000 kW, and switchyard are located immediately downstream. TN State Highway 96 traverses the top of the dam. Center Hill Lake, created by the dam, impounds 2,092,000 acre-feet at its maximum flood control pool elevation (EL, National Geodetic Vertical Datum of 1929, commonly referred to as feet above mean sea level) EL 685. All project uses except flood control, are drawn from the power pool located between elevations EL 648 and EL 618. Under normal operations, the average maximum summer lake is EL 648, and the average minimum winter lake is EL 623.5.

Since construction, seepage problems through the karst limestone foundation have required diligent monitoring, subsurface investigations and grouting. Despite past work, seepage has increased to an unprecedented level of approximately 130 cubic feet per second under normal lake operations. Foundation conditions are deteriorating because clay-filled joints in the rock within the rims and dam foundation are eroding. This chronic erosion jeopardizes the two earthen embankment dams, the abutments and the integrity of the rims resulting in a high potential for dam failure. Center Hill Dam is ranked in Dam Safety Action Classification I -- the highest category of risk and urgency for dam safety major rehabilitation. A report titled, Center Hill Dam, DeKalb County, Tennessee, Seepage Control, Major Rehabilitation Evaluation Final Report, 14 July 2006, evaluated seepage problems and provided justification for a major rehabilitation project at Center Hill Dam. The report also contains Environmental Assessments that considered different dam repair alternatives. The repair alternative selected will use a combination of grout injection and cut-off walls.

Continued, uncontrolled seepage creates the potential for partial loss of the reservoir or for dam failure. Karst foundation seepage is difficult to accurately predict, however, in the unlikely event of failure, downstream damages would likely exceed a billion dollars. Potential loss of life could exceed several hundred people.

An unscheduled emergency action would likely result in lowering the pool as quickly as possible, well below the existing normal maximum and minimum pool elevations to reduce risk downstream to people and property. However, this action would result in significant impacts. As a proactive measure, the Corps is evaluating different interim lake elevations that would reduce hydrostatic pressure and balance the risk of dam failure with the impact to project purposes and environmental resources. The purpose of this Draft Environmental Impact Statement is to analyze possible impacts resulting from interim pool elevation alternatives and an unscheduled emergency drawdown that could occur during 7 – 10 years

of repairs to the main and saddle dam foundations, earth embankment, dam abutments, and rim walls. When repairs are complete, the increase in reliability extends the project life resulting in continuing project benefits, and Center Hill Dam and Lake would return to status quo lake operations.

The Corps has recently modified the normal maximum summer pool elevation (EL 648) to a maximum average EL 640, the bottom of the normal pool, to reduce the risk of dam failure. The aim of reducing high pools typically experienced in the winter and spring months, will take some stress off the dam foundation and associated structures. This modified operation also preserves the coldwater fisheries below the dam.

The lower summer pool (EL 640) will be maintained until repairs are sufficiently complete to reduce the risk of dam failure. However, repairs will take 7 - 10 years to complete and during this time, it is possible that lake elevations could drop below the current average maximum and minimum pool elevations of EL 640 and EL 623.5 respectively. Significantly lower lake elevations could substantially impact project purposes and important resources.

Corps personnel are closely monitoring the dam. Seepage repairs will also be closely monitored. The District has identified a number of distress indicators that would prompt an immediate unscheduled emergency drawdown of the lake. These distress indicators are:

- worsening seepage conditions,
- the occurrence of abnormal piezometer water level readings,
- the presence of increased wet areas and springs downstream the embankment toe,
- the development of muddy water below the dam,
- worsening conditions in current sinkholes or the development of new ones,
- developing cold zones and settlement of the dam embankment,
- development of a whirlpool above the dam,
- the results of a Formal Risk Assessment, or, other new information

The national economic development (NED) plan is the alternative that yields the highest positive net benefits. The NED plan, and recommended plan, is to install permanent cutoff walls and supplemental grouting into the main dam embankment, main dam and saddle dam foundations, and rim walls to arrest seepage. The recommended plan includes installation of an orifice gate over a sluice gate to provide a continuous and well oxygenated minimum flow of 200 cubic feet per second (cfs) to augment flow for water quality downstream of the dam. The recommendation yields net NED annual benefits of over $36 Million and has a Benefit-to-Cost ratio of 3.4. The total cost of the plan is $240 Million. The dam repairs are estimated to be completed in 7 – 10 years. The cut-off wall is designed for a 50 year life. During the fifty year period, two maintenance grouting projects are planned. The first is scheduled about 18 years after completion of dam repairs followed a second grouting program, 18 years later.

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1.0 Purpose And Need For Action

1.1. Authority. The Flood Control Act of 1938 authorized construction of Center Hill Dam. Supplementing authorizations were the Third Supplemental Defense Act of 1941, the Flood Control Act of 1944, and the River and Harbor Act of 1946. Section 4 of the Flood Control Act of 1944 authorized the Chief of Engineers to construct, maintain, and operate public park and recreational facilities and to permit construction, maintenance and operation of such facilities. The Federal Water Project Recreation Act of 1965 established development of the recreational potential at federal water resource projects as a full project purpose. The Fish and Wildlife Coordination Act (16 USC 661) and the Fish and Wildlife Conservation Act of 1980 (16 USC §§ 2901 – 2911) recognized "…the vital contribution of our wildlife resources to the Nation…" and provided that "…wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs…" The Clean Water Act (33 U.S.C. 1252 § 102(b)) added water quality to the Corps' mission at water-resource development projects. The River and Harbor Act of 1958 (43 U.S.C. 390b), authorizes the Secretary of the Army to include municipal and industrial water storage in Corps projects and to reallocate storage in existing projects to municipal and industrial water supply. As a result of these legislative actions, the currently authorized project purposes for the Center Hill Lake Project are flood control, hydropower generation, recreation, fish and wildlife management, water quality, and municipal water supply. Although not specifically authorized, the water flowing through Center Hill Dam for the above authorized purposes also contributes to navigation on the lower Cumberland, Ohio and Mississippi Rivers.

The National Environmental Policy Act (NEPA) of 1969, as Amended, requires that prior to making any decision that would entail any irreversible and irretrievable commitment of resources, a Federal agency shall consult with and obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved, and shall solicit public input and comment. The Corps, nevertheless, has the authority in cases of emergency to prevent or reduce imminent risk of life, health, property, or severe economic losses, to take immediate action under the conditions set forth under 33 CFR 230 – Procedures for Implementing NEPA; part 230.8 – Emergency actions. However, this DEIS is being processed as a proactive measure to avoid the potential need to employ emergency NEPA procedures.

It should be noted that Wolf Creek Dam near Jamestown, Kentucky, is experiencing similar foundation problems. At Wolf Creek an emergency was declared and the lake levels were lowered significantly. A DEIS for that action is being prepared concurrently with this document. Together the two dams control the flow of approximately 80% of the water in the Cumberland River. Ordinarily, if only one reservoir was affected the other would be available to alleviate the impacts. However, with both reservoirs affected the problems are compounded.

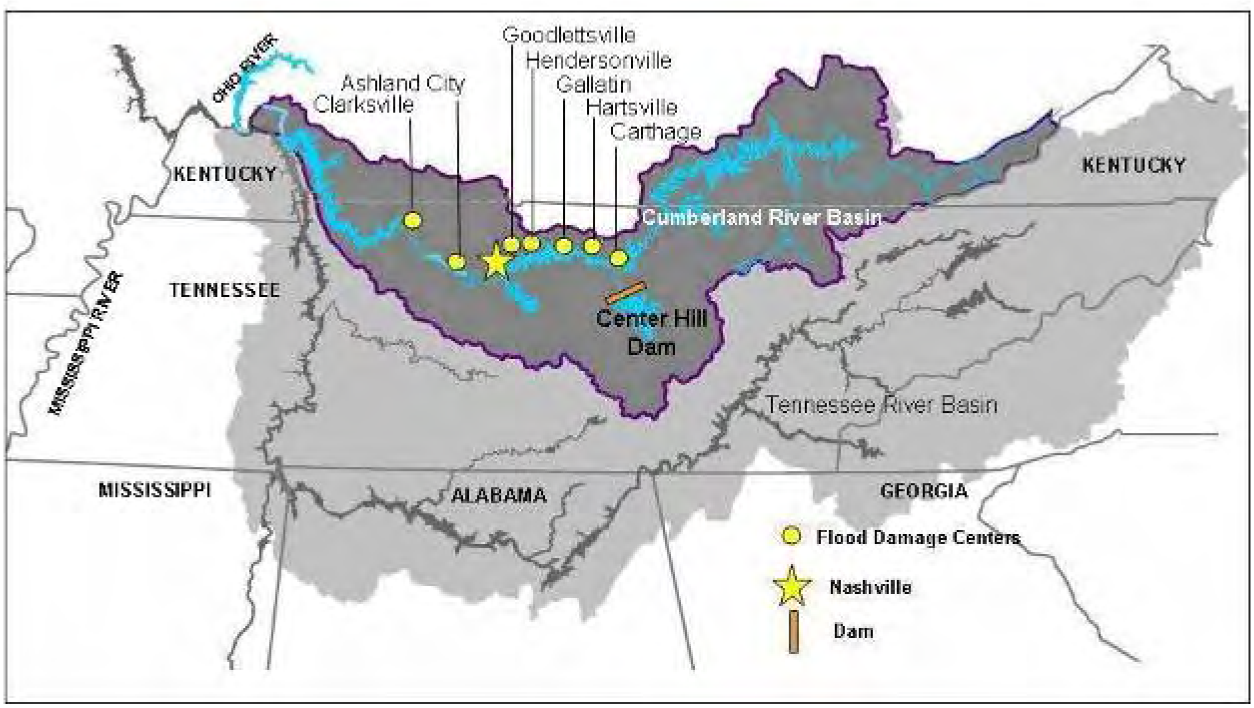
The U.S. Fish and Wildlife Service (USFWS) is the Federal Agency with jurisdiction by law or special expertise to work with others, to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The Service helps protect a healthy environment for people, fish and wildlife, and helps Americans conserve and enjoy the outdoors and their living treasures. The USFWS's major responsibilities pertaining to the Center

Hill Project are for migratory birds, endangered species, and freshwater and anadromous fish. Because of this expertise, the USFWS is a Cooperating Agency for this DEIS.

The Tennessee Valley Authority (TVA) is a federal corporation and the nation's largest public power company. TVA's major responsibilities are to minimize flood risk, produce power, maintain navigation, provide recreational opportunities, and protect water quality within the Tennessee River Basin. However, Great Falls Dam, acquired by TVA from a private company, is the only TVA-owned dam within the Cumberland River Basin and outside the Tennessee River watershed. Great Falls Dam is located on the Caney Fork River, upstream from Center Hill Dam near river mile 91.1 in Warren County, Tennessee. TVA also has two coal-fired power plants along the Cumberland River that might be affected by any flow changes in the Cumberland River. Because of water management expertise, and potential effects from operation changes at Center Hill Dam, TVA is a Cooperating Agency for this DEIS.

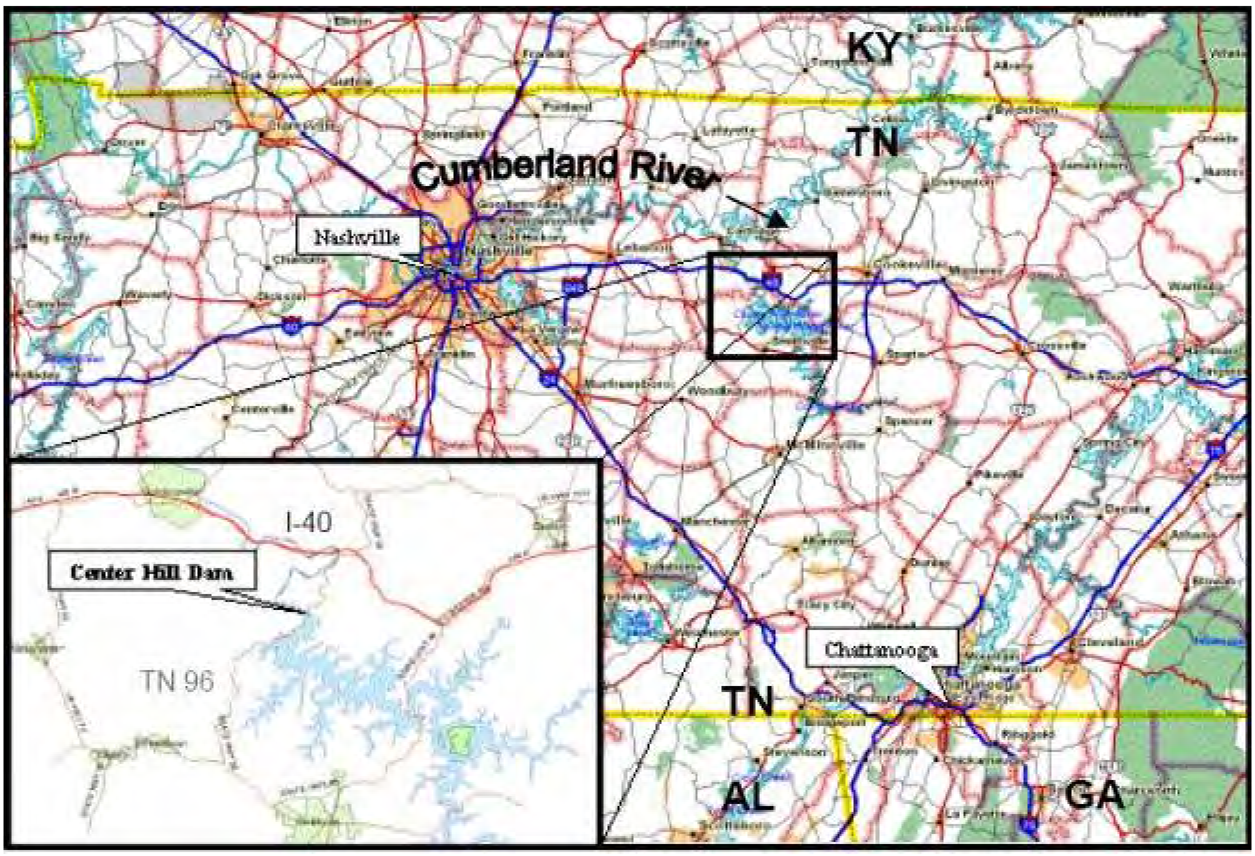
1.2. Background. Center Hill Dam is a significant feature of the Cumberland River Basin. In the early part of the 20th century, major floods occurred in the Ohio and Mississippi River basins, which resulted in disastrous losses of lives, property, and economic stability. Ensuing public outcry for government agencies to take protective measures led to the development in 1937 of a comprehensive flood control plan by the U.S. Army Corps of Engineers (Corps). The comprehensive plan proposed construction of 45 flood control reservoirs in the Ohio River basin. Six flood control reservoirs were recommended for the Cumberland River Basin, of which four were eventually built. These four are Wolf Creek (Lake Cumberland), Dale Hollow, Center Hill, and J. Percy Priest Dams. Figure 1 shows the location of Center Hill Dam and major downstream potential flood damage centers.

Figure 1 – The Cumberland River Basin, Center Hill Dam, and Potential Flood Damage Centers.



Center Hill Dam is a large, high head dam located near Lancaster, Tennessee at Caney Fork River Mile 26.6 (Figure 2). It controls runoff from a drainage area of 2,174 square miles, which includes the 1,675 square miles controlled upstream by TVA's Great Falls Dam. The dam is a combination earth fill and concrete structure 2,160 feet long and 250 feet high, with a gated spillway structure. Construction began in March 1942 and was delayed for three years by World War II. Dam closure was started November 27, 1948 and was completed December 1949. The average discharge below the dam is 3,800 cubic feet per second. The maximum lake depth is 173 feet and the approximate lake retention time (the average length of time water remains in the lake) is 130 days. The first power unit was placed in commercial production in December 1950. The power plant consists of three 45 mega watt units that generate an estimated average of 351,000 mega watt hours annually. Under full operation, each unit discharges 3,750 (11,250 total) cubic feet per second of flow below the dam.

Figure 2 – Center Hill Dam Location Map within Tennessee.



<u>1.2.1 Center Hill Water Control Manual.</u> In order to understand the effect pool elevations have on Center Hill project purposes and ultimately on important resources, it is important to understand how the pool is managed. The information summarized below comes from the following 1998 document: <u>Cumberland River Basin, Volume VIII, Center Hill Water Control Manual</u>.

The Center Hill Project Guide Curve (Figure 3) represents the primary guidance for operations at Center Hill Dam. The Center Hill pool is divided into distinct pools (layers) based on three congressionally authorized elevations (EL 685, 648, and 618) which form operating boundaries for project purposes throughout the year. These operating pools are described below.

Inactive Storage Pool. The bottom layer of Center Hill Lake is the inactive storage pool, also referred to as the conservation or permanent pool, extends from the bottom of the reservoir up to EL 618. The hypolimnion develops in this layer during the summer. Water is not released if it would bring the surface of the pool below EL 618. Inactive storage is provided primarily to offset lake sedimentation and provide head for hydropower. Other project purposes supported by this permanent pool include depth for recreation in the lake, water intake coverage, and lake habitat for fish and other aquatic life.

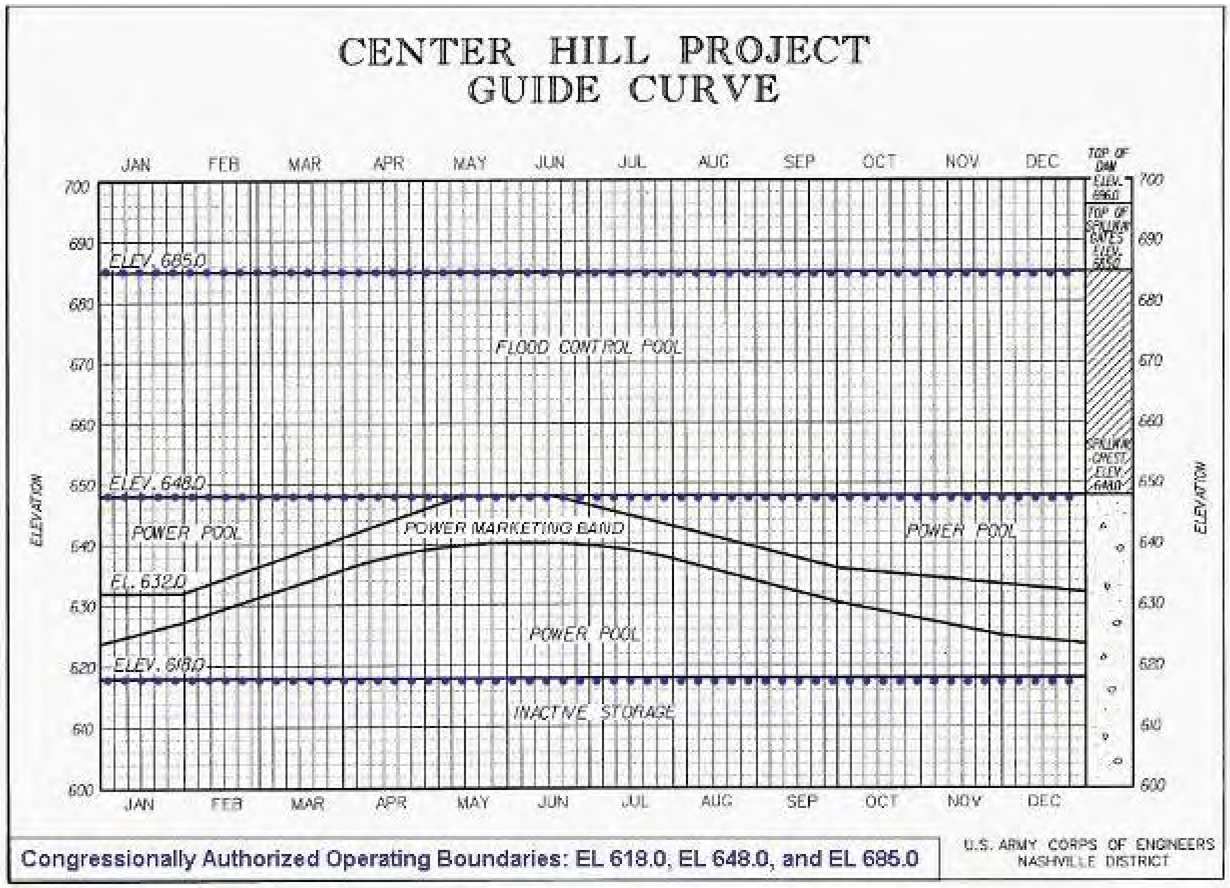
Power Pool. The power pool extends from EL 618 up to EL 648. This 30 foot depth is the "normal" operating zone of the reservoir. This is the zone in which water is stored for hydropower and other project purposes. The average maximum pool, EL 648, is commonly referred to as the Normal Summer Pool. And the average minimum pool, EL 623.5, is commonly referred to as the Normal Winter Pool.

The power pool is further subdivided by two curves which define a continually varying zone or band of water within the power pool. This area is commonly referred to as the "SEPA power marketing zone" but is more accurately called the “Power Marketing Band” (PMB) in this document. SEPA is the acronym for the Southeastern Power Administration which is the Federal entity responsible for marketing the power generated by all Corps projects in the Nashville District. The PMB ranges in depth from 4.85 to 8.5 feet, but commonly operates between 6.0 and 6.5 feet. The location of the band within the full power pool varies depending on season. The power pool is usually permitted to fill during wet winter and spring months and remain around EL 648 from mid-May through mid-June. During the summer and fall seasons, hydropower releases result in a steady drawdown of the reservoir, following the PMB. The PMB is targeted to reach EL 623.5 near the end of the calendar year. This elevation is 5.5 feet above the bottom of the power pool (EL 618).

The PMB band represents the optimal range for power generation within the power pool. As a result of a daily analysis of current hydrologic conditions, the Corps’ Water Management Section coordinates with TVA to schedule a specific amount of energy production for the week at Center Hill and, if needed, to modify the generating schedule for the current day. TVA accepts this daily total generation schedule and then schedules the energy on an hourly basis to best meet power demands. The Corps and TVA work together to prevent deviations from the prescribed daily generation schedule.

Flood Control Pool. The flood control pool extends from EL 648 to EL 685. The normal condition is for this pool to remain empty so that space is available for flood water storage. Following a flood event, water is released from this pool as quickly as possible based on downstream conditions in order to restore the capability to provide protection from future flood events.

Figure 3. Center Hill Lake – Congressionally Authorized Pool Elevations and Power Marketing Band (PMB).



1.2.2 Significant Pool Elevations. In addition to congressionally authorized pool elevations, location of specific structural features in the dam limit water withdrawal at specific elevations. Significant pool elevations are shown in Table 1. These elevations were considered in developing interim pool elevation alternatives.

Table 1. Significant Pool elevations. Bold denotes congressionally authorized elevations.

Center Hill Pool Elevations (ft)	Physical Feature
696.0	Top of Dam
685.0	Top of Flood Control Pool
681.5	Flood of Record (May 1984)
648.0	Top of Power Pool and spillway crest Top of PMB (Average Maximum Summer Pool)
640.0	Modified Summer Pool – Current Conditions
635.0	First problems with boat launching ramps
625.0	First boating issues at marinas
623.5	Bottom of PMB (Average Minimum Winter Pool)
622.0	90% of the Boat Ramps out of service
620.0	Cavitation Issues with turbines during Power Production All boat ramps out of service; all 9 marinas impacted
618.0	Bottom of Power Pool
616.0	Upper Water Intake (City of Smithville)
540.0	Penstock openings to hydropower generators
496.0	Bottom of Sluice Gate

1.2.3 Standard Pool Elevation Operations. It is important to understand standard operations so that deviations can be identified and the degree of impact interpreted. Center Hill Dam and Lake have operated under a water control plan since project completion. The Center Hill Water Control Manual (1998) guides day to day and emergency regulation of the Center Hill project. It also contains special regulations to cover special circumstances such as providing specific water levels or releases for construction activities, project maintenance, inspections, and response to emergency situations such as drownings and chemical spills. Emergency procedures exist for flooding and drought conditions. A 1994 Drought Contingency Plan (DCP) guides operations during a dry rainfall year. Because of a 56 year history, the project has experienced all ranges of elevation so some perspective of impact can be assessed.

Flood Control. As illustrated by Figure 3, storing water for flood control is a primary function of the Center Hill Project. Any water elevation that drops below the PMB and power pool, increases flood water storage and protection. This would be true under any rainfall condition. Under normal flood operation, dam releases are reduced to provide flood protection to downstream damage centers. Flood control operations include limiting Center Hill Dam releases to the channel capacity of the Caney Fork River below the dam, which is about 30,000 cfs. Large surges in releases can cause bank erosion, adversely impact recreational users below the dam, and make commercial navigation much more difficult downstream on the Cumberland River. Under the Emergency Operations Schedule (EOS) downstream flood reduction is an objective, but protection of the dam structure is the prime concern. In extreme cases, if limiting the project discharge to 30,000 cfs results in exceeding the flood pool (EL 685.0) then more water is released to prevent overtopping the dam while minimizing releases as much as practical.

Hydropower. Under normal operations, the water surface elevation behind Center Hill Dam is maintained within the PMB. Releases are made through the turbines as governed by the demand for power. Hydropower is optimized when the power pool is above or within the PMB.

As discussed in the Drought Contingency Plan (Corps, 1994), hydropower is incrementally reduced as the power pool is reduced when there is not enough water in Center Hill Lake to support all project uses. And if the combined volume of water in the power pools of Wolf Creek, Dale Hollow and Center Hill are cumulatively reduced by nearly 30%, below the PMB, then hydropower releases may be reduced to a combined minimum daily average of 3,600 cfs. If the combined volume of water in the three power pools is less than 70% below the PMB, then hydropower releases may be reduced to a combined minimum daily average of 2,000 cfs. Under drought conditions, hydropower is severely affected. When it becomes apparent during a drought condition that there is not enough water available in the Cumberland River system to meet hydropower needs without endangering the long-term viability of public water supplies and coal-fired steam plant needs, then hydropower from the dams may be temporarily suspended.

Cooling water supply for electrical generation at steam plants, is not an authorized project purpose at Center Hill, however, it is tied to hydropower generation. The Cumberland Steam Plant alone needs a minimum daily flow between 4,000 and 6,000 cfs to provide electricity to the power grid. Power generation at this plant is almost three times the capacity of all nine Corps plants in the Cumberland River Basin combined, using only about 9% of the water required by the dam hydropower plants. Therefore, every effort is made to provide this flow as long as other project purposes are not impacted. In an effort to meet a more uniform flow, peaking operation at the hydropower plants can be eliminated to support thermal power. During drought, it may be necessary to provide flows which are less than the optimal amount.

<u>Minimum Flows</u>. In general, hydropower releases are scheduled to meet peak energy demands. Normally this results in more water being discharged during the week and less on the weekends. Strict adherence to peak power demand scheduling would result in adverse affects to the aquatic life in the tailwater, particularly during the low flow, low dissolved oxygen, high temperature months of the late summer and early fall. Every effort is made to provide some discharge in excess of the minimum requirement every day of the week to supply cold water flow downstream of the dam to support the coldwater fishery and downstream TVA coal fired steam plants. The tailwater trout fishery, and steam plants are sensitive to water temperature increases. Warm water temperatures are detrimental to trout, and the steam plants need cold water for cooling purposes.

<u>Water Quality</u>. Water quality is a primary consideration for the operation of Center Hill during both normal and drought periods for public health and safety. Old Hickory Dam is considered the water quality trigger point for Cumberland basin system operations. Generally, when desirable dissolved oxygen conditions in releases from Old Hickory are maintained, acceptable water quality conditions along the Cumberland River mainstem are assured. The Tennessee water quality standard for dissolved oxygen is a minimum of 5.0 mg/1 to support a warm water fishery. Minimum bi-weekly average flows needed to meet this standard below Old Hickory have been estimated and are presented in Section 3.5 Tailwater Releases, Table 4.

Old Hickory discharges are influenced by hydrologic conditions and the Cumberland River system requirements to move water through the basin. There is no significant storage capacity in Old Hickory Lake to supply such flows therefore it depends on combined releases from the upstream storage projects of Center Hill, Dale Hollow, and Wolf Creek Dams to meet this need. Every effort is made to maintain an acceptable level of dissolved oxygen in the Old Hickory tailwaters.

Center Hill Lake water quality can be described as good, even though it has some dissolved oxygen (DO) problems. Mean summer depth in the reservoir is about 73 feet and mean retention time is about 140 days. At times the hypolimnion has exhibited low DO causing cool water fish to migrate away from the center of the lake. This typically occurs during the summer months. Nutrients can also be a problem. The runoff into the lake is from mostly agricultural areas, and some high nutrient levels are cause for concern at times. Major wastewater discharges into the lake are from the cities of Cookeville, McMinnville, Smithville and Sparta.

Tailwater Trout Fishery. The Caney Fork River below Center Hill Dam supports a viable put, grow, and take trout fishery. The tailwater is classified as a trout stream by the state (TDEC, 2004a and 2004b). The Tennessee water quality dissolved oxygen standard for a trout stream is 6.0 mg/l; and a water temperature of less than 20º C (68º F). In the late summer and early fall months the dissolved oxygen level of the Center Hill discharge often falls below this standard. During such occurrences the turbines may be operated at reduced capacity to increase the tailwater dissolved oxygen level to protect the fishery resource. However to avoid excessive wear, the turbines are generally not operated below their cavitation limits (EL 620). To improve the dissolved oxygen, a sluice gate is opened. The gate is located near the bottom of the dam. It draws from the coldest water in the lake. Hydraulic pressure creates a turbulent flow that oxygenates the discharge. This method has been effective in improving dissolved oxygen and maintaining cold water temperature in the tailwater.

Drought Regulation. Operations under drought conditions are specified in the Corps' 1994 Drought Contingency Plan (DCP). The DCP was developed because of the 1988 drought, and contains emergency measures that would be followed in the Cumberland River system in the event of future droughts. The DCP prioritizes project and system purposes in the event of a water shortage. When there is not enough water in Center Hill Lake or in the Cumberland River system, priorities for drought regulation are: 1) Water Supply (For Public Health and Safety); 2) Water Quality (For Public Health and Safety); 3) Navigation; 4) Hydropower; and 5) Recreation. These priorities will remain in effect at Center Hill Dam during the 7 – 10 year dam repair period regardless of the interim pool elevation alternative selected. Center Hill serves as one of the prime reservoirs maintaining desired Cumberland River flows during drought. Under drought conditions, most of the water flowing in the Cumberland River is comprised of the combined releases from Center Hill, Dale Hollow, and Wolf Creek Dams.

Only hydropower and flood control are specifically mentioned as authorized project purposes. However, during drought, flood control is not a factor. Center Hill Dam is also operated for water quality and fish and wildlife under the general authorities of the Federal Water Pollution Control Act Amendments and the Fish and Wildlife Coordination Act respectively.

Municipal Water Supply. Center Hill Lake serves as the water supply source for the cities of Smithville and Cookeville. The minimum pool level at which the two systems withdraw water is EL 616; two feet below the top of the inactive pool. Water supply storage has been reallocated at Center Hill Dam. The current users are the City of Cookeville, City of Smithville, and Riverwatch Resort. Consequently, in the interest of public health and safety, high priority is given to maintaining the lake level at an elevation that ensures all water supply intakes covered, unless an emergency drawdown below EL 618 is required for safety reasons.

Navigation. Navigation is not a project purpose at Center Hill. However, hydropower and minimum flow releases provide flow that coincidentally supports navigation while addressing other project purposes. Flows from Center Hill, in combination with other sources, contribute to adequate depths for navigation through the lower Cumberland River.

Recreation. Recreation is prioritized last in the DCP. Water would be conserved in the power pool to meet recreation needs to the extent possible. However, under drought or emergency conditions, recreation may be sacrificed to meet other higher priority purposes. The lake would still be open to the public even if there were no usable boat ramps for easy lake access.

Fish and Wildlife. Usually in late April or early May, the largemouth bass and crappie spawn occurs. For a two to three week period during this event it is critical to keep a relatively stable pool for good spawning conditions. If however, water should rise in the flood control pool and releases are necessary, an attempt would be made to release as rapidly as practical to attempt a delay in the spawn until the pool is stable. The Tennessee Wildlife Resources Agency (TWRA) identifies the beginning of the spawning period for all lakes in Tennessee when water temperature at a five-foot depth is at or above 60 degrees Fahrenheit. Stabilization efforts are initiated when the Corps determines that temperatures are appropriate for the spawn to occur. Lake level stabilization to enhance the fish spawn is a cooperative effort between the Corps, TWRA, SEPA, and TVA.

Safety. Special regulations cover changes to lake operations under unique circumstances. Temporary changes to lake elevations or release volume may be necessary during construction activities, project maintenance, inspections, or response to emergency situations such as drowning and chemical spills. Normally unique events can occur within normal lake operations. In rare circumstances when long-term deviation from normal operations is necessary, prior approval from the Corps' Great Lakes and Ohio River Division (LRD) Office is required.

Maintaining the integrity of the dam structure under all conditions of pool elevations takes precedence over maintaining any project purpose. This requirement assures the safety of the general public in the lake and in the river system below the Center Hill project. The Center Hill Water Control Manual (Corps, 1998) and the Drought Contingency Plan (Corps, 1994) are intended to result in safe conditions for all anticipated circumstances. However, if conditions arise where adherence to either plan would jeopardize structural integrity of the dam or the general public, safety conditions should prevail.

1.2.4 Normal Operating Guide Curve. As previously stated, in order to understand the effect interim pool elevations has on Center Hill project purposes and ultimately important resources, it is important to understand how the existing pool elevations are managed. Center Hill Lake pool elevations follow a prescribed schedule of elevations designed to best meet all the project purposes of flood control, hydropower, recreation, fish and wildlife, water quality, and water supply.

The PMB is actually a narrow band of water elevations that range between 4.8 and 8.5 feet deep (Figure 3.) This narrow band of water elevations rises and falls in a predicable pattern over the calendar year. The customary summer pool elevation in June is usually EL 648. However, a summer pool at EL 640, while near the bottom of the PMB, would still be considered within the normal operating range. Winter pool is the lowest elevation maintained in December customarily around EL 623.5. However, under normal operating conditions, a winter pool of 632, though at the top of the PMB, would still be considered within normal operations.

In order to regulate Center Hill Lake pool elevations, headwater and tailwater elevations must be monitored. Lake levels are measured at the dam and are referred to as headwater elevations that are shown in Figure 4 for years 2000 - 2007. Water released below the dam is referred to as tailwater discharge. Tailwater elevation varies with discharge volume.

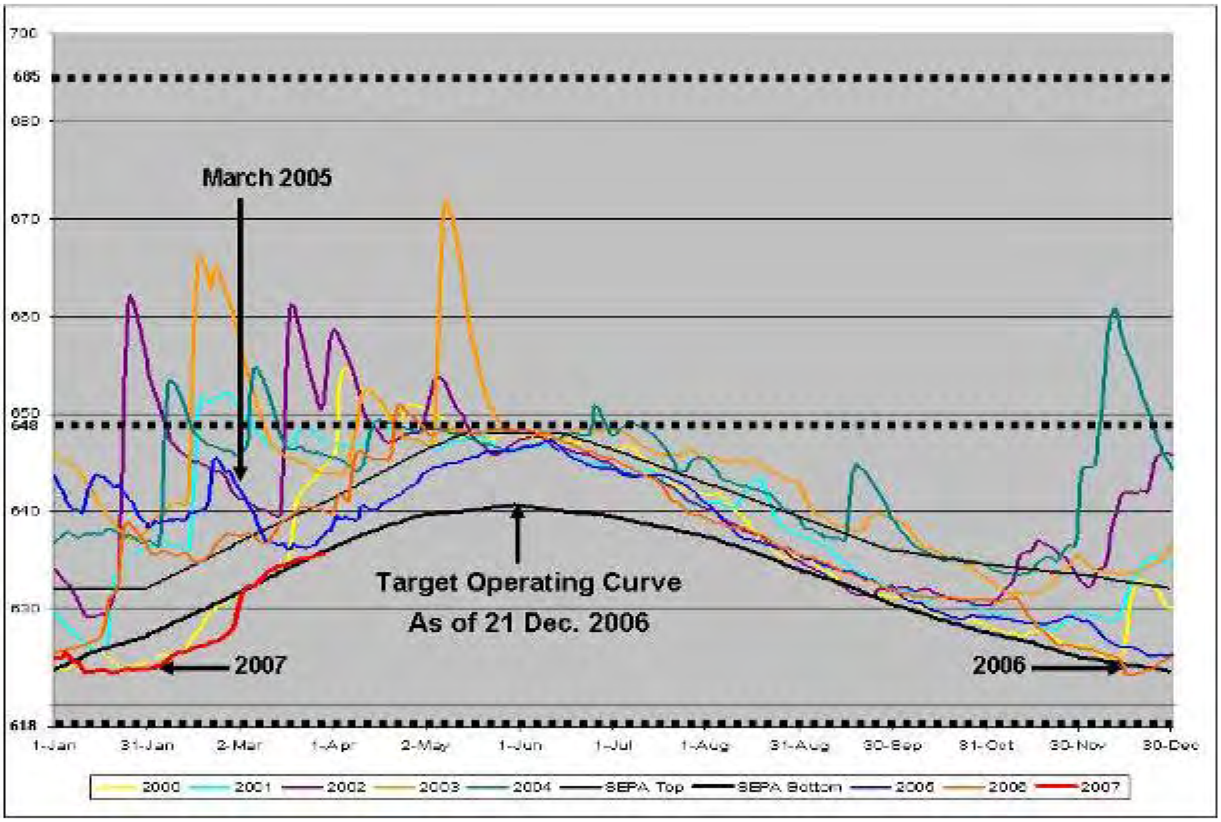
Prior to 2005, winter and spring rainfall was routinely captured in Center Hill Lake to maximize downstream flood protection and hydropower generation. Headwater elevations commonly exceeded the top of the normal operating guide curve. Since one of the primary purposes of the project is flood control, flood water is stored and then slowly released, sometimes via hydropower generation, in a regulated discharge with the final goal of maintaining the pool within the Guide Curve elevations. Examples of routine pool elevation management are shown in Figure 4 for the years 2000 to 2004.

It is important to note how rainfall events affect pool elevation management. During periods of little rain, pool elevation can dip below the bottom of the PMB. This situation occurred in 2000 because other project purposes were still drawing from the pool. Eventually inflows add enough water to raise the pool within the PMB. Under drought conditions, the pool may fall below the PMB for an extended period of time. The pool is still managed to meet project uses though at the expense of hydropower generation.

Wet years, as seen for 2003 and 2004 (Figure 4) routinely produced high headwater elevations that were routinely above the top of the power pool (EL 648). These two years exemplify the resilient flood storage capacity of the project. Under normal conditions, high lake levels could be sustained above EL 648 for a long period of time.

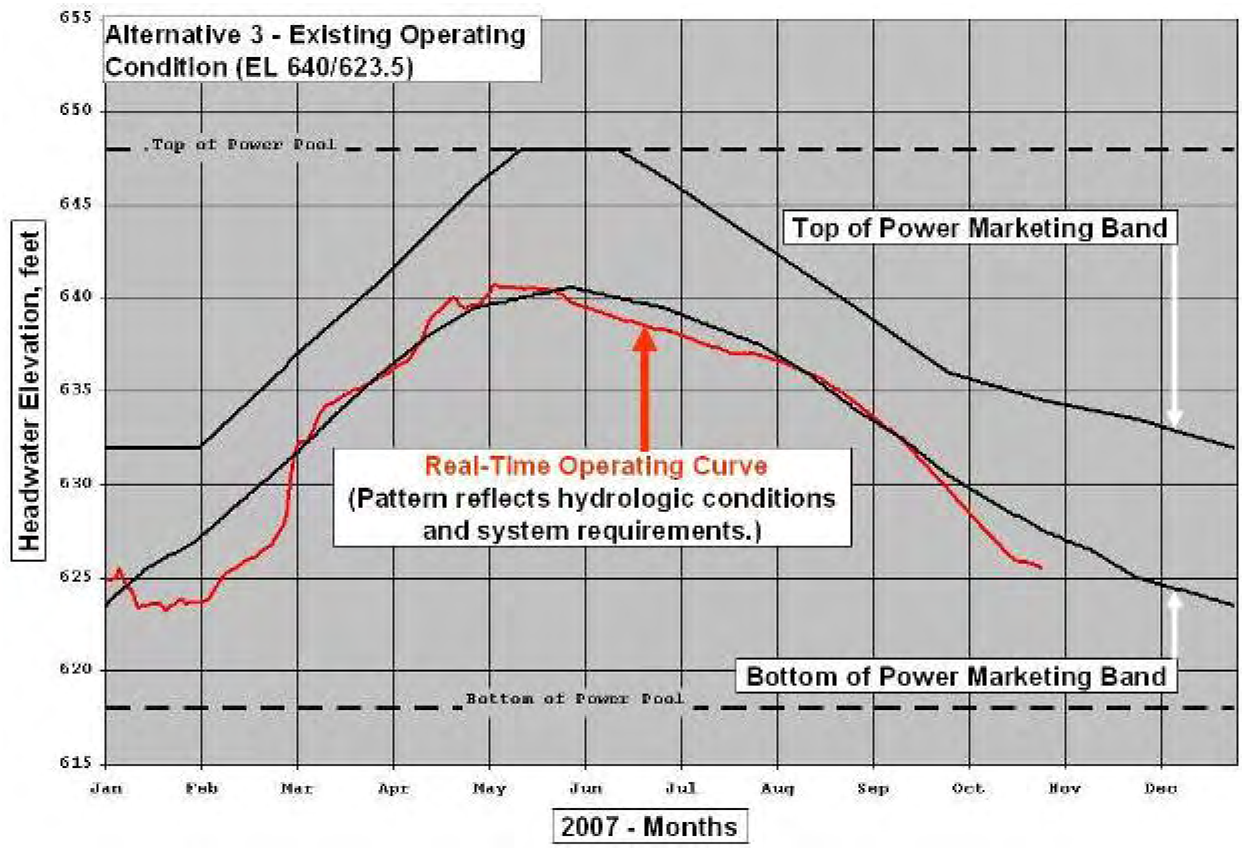
1.2.5 Modified Operating Guide Curve. In 2004, Center Hill Dam inspections revealed increasing seepage and structural problems. Several alternatives to address these problems were considered as previously described. The alternative selected was to repair the project structures using a combination of grouting and cut-off walls. Beginning in March 2005, the pool has been managed more aggressively to reduce inflow peaks and to maintain the lake elevations within, the PMB (Figure 5). This action markedly reduced the high peaks of pressure on the main and saddle dam foundations, earth embankments, and right and left rim walls. Over the last two years there has been a documented reduction in the size of wet spots at the embankment toe. There has also been a marked decrease in the flows from the springs immediately below the dam that serve as seepage indicators. As a result, the Corps planned to maintain lower lake elevations.

Figure 4. Center Hill Lake inflows for 2000 – 2007.



In December 2006, the Corps determined that the safest operation that would also maintain project purposes would be to aggressively adhere to the bottom of the PMB (Figure 5). This modified operation plan is anticipated to remain in effect until repairs are sufficiently complete. However, repair time will take many years. It is therefore possible that emergency circumstances could dictate lowering lake elevations well below the PMB substantially impacting project purposes and important resources. For this reason, this DEIS is written to address significant impacts that could result from highly altered interim pool elevations including No Action (Existing pool operations).

Figure 5. Existing Pool Elevation Operation (EL 640/623.5), Center Hill Lake.



<u>1.3 Previous Studies.</u> Numerous reports and studies have been completed at Center Hill Dam and Lake and are cited in the document entitled, <u>Center Hill Dam, DeKalb County, Tennessee, Seepage Control, Major Rehabilitation Evaluation Final Report, LRD Review, 14 July 2006</u>. These documents include Center Hill Dam and Lake Master Plans, O&M Plans, design plans, security plans, and spill plans. An Environmental Assessment (EA) was completed for remediation of the left and right rim and a Finding of No Significant Impact (FONSI) was signed on July 17, 2005. During the study process, additional repair alternatives were identified for the main dam embankment and saddle dam. Therefore, a Supplemental EA was completed and a FONSI was signed on 19 May 2006. All these documents are incorporated by reference in this DEIS and may be viewed in the Corps' library in Nashville, Tennessee.

<u>1.3.1. Seepage Rehabilitation Alternatives Considered.</u> The 2005 and 2006 NEPA documents considered and screened several alternatives to reduce the potential of dam failure and reduce risk to downstream populations. Alternatives considered are: 1) no action to repair the dam, 2) roller-compacted concrete dam constructed at the toes of the main dam and saddle dam earthen embankments, 3) remove generators to allow the water to flow freely through the dam, 4) dam removal, 5) grouting only, and 6) permanently lowering the lake. Details can be found in the EAs noted above.

1.3.2. Selected Seepage Rehabilitation Plan. The alternative selected to control seepage and strengthen main and saddle dam foundations, earthen embankments, and rim walls was to repair the structures. Repairs are scheduled to begin in Fall 2007. The repair alternative finally selected consists of a combination of grouting and installation of cement cut-off walls into the earth embankments of the main and saddle dams. Grouting would consist of conventional cement grout alone or in combination with hot bitumen. A cut-off wall is constructed using panels or piles that are overlapped to form a continuous wall unit into the foundation rock to cut off seepage. This plan is expected to be highly effective in reducing seepage, strengthening the dams, embankments, and rim walls, and reducing risk of dam failure.

It is anticipated that dam repairs will take 7 – 10 years to complete. During this time period, the dam and associated structures are vulnerable due to substantial hydrostatic pressure resulting from high lake elevations. While not expected, in the emergency of rapid erosion of solution features, or appearance of some other distress indicator, the lake could be drawn down as quickly as possible until safety concerns were reduced to an acceptable level.

Several steps have already been taken to reduce the potential for dam failure and minimize risk to downstream populations. While safety is the priority, attempts are on-going to safely maintain all lake purposes. Protective actions include: 1) increased dam inspections and monitoring, 2) emergency action planning with state and local emergency management services (EMS), 3) dam safety training for project personnel, 4) installation of monitoring equipment, 5) public meetings to inform the public of the seepage problems, potential dam fail, and repair options at Center Hill Dam, and 6) recreational facilities and boat ramp notifications.

1.3.3. Emergency Action Planning. The Corps and State Emergency Management teams have conducted a number of exercises and have revised emergency notification procedures through the National Oceanic & Atmospheric Agency's National Weather Service and the Weather Radio System. The Corps is collaborating with the federal, state, and local` agencies to develop an emergency action plan in the event of an extreme lake drawdown emergency.

1.4. Purpose and Need for Action. The Flood Control Act of 1938 authorized Center Hill Dam construction. The dam was designed in the 1930s, constructed in the 1940s, and completed in April 1951. The dam was built on a karst geology using accepted engineering practices of the day. Since the 1960s seepage through the main and saddle dam foundations, earthen embankments, left and right rims, has been a concern. Repairs have been implemented at various times including grout injection into the main dam foundation and the left and right rims. Those repairs are credited with saving the dam and significantly reducing seepage. However, over the years continued seepage has undermined geology unaffected by grouting. Over the last three decades the problems have increased and based upon the Dam Safety Portfolio Risk Assessment, the dam is now classed as being in an active failure mode.

Due to the risk imposed on downstream populations by the dam's instability, the Corps found it necessary to modify lake operations until repairs are completed. Since March 2005, the Corps has attempted to keep fall, winter and early spring lake levels from extreme rises due to high inflow. Seepage problems are made worse during continual high lake levels. As a result, the Corps plans to maintain lower lake levels, but still within the normal operating guide curve, to reduce pressure on the main and saddle dam foundations, earth embankments, and rim walls until a permanent remedy is in place. A major grouting project to address the dam seepage is scheduled for the fall of 2007, followed by installation of a cutoff wall through the earthen portions of the main and saddle dams. These repairs are scheduled for completion in 2014. Although not expected, the Corps may have to rapidly lower the lake pool significantly below the operating pool at any time during the 7-year repair phase because of the following distress indicators:

- seepage conditions worsen
- occurrence of abnormal piezometer water level readings
- the presence of increased wet areas and springs downstream the embankment toe
- the development of muddy water
- worsening conditions in current sinkholes or development of new ones
- development of cold zones and settlement of the dam embankment
- development of a whirlpool above the dam,
- results of a Formal Risk Assessment, or
- other new information

Any one or a combination of the above distress indicators may determine that an unscheduled emergency drawdown of Center Hill Lake is necessary to reduce risk to the public's safety and welfare.

The purpose of lowering the lake is to reduce stress on the foundation and the consequences of a failure. Lowering the lake significantly below the operating curve under interim pool elevations or emergency drawdown for extended periods of time would have many significant impacts to hydropower production, thermal power plant generation, water quality, fish and wildlife, recreation, municipal water supplies, economics, navigation, and possibly cultural resources. Accordingly, the Corps has prepared this DEIS prior to making any long-term decisions regarding interim pool elevations in compliance with environmental laws and regulations including NEPA.

1.5. Public Review Process. Prior to this review, the Corps has conducted numerous public meetings to advise the public of problems with the dam, and has created a website on the Nashville District's home page to provide the public a status report of the project and current actions. The Corps has also collaborated with the emergency management community to update emergency notification and evacuation planning. The purpose of this DEIS is to review current actions taken, consider other possible alternatives to reduce stress on the dam, and to address operational changes that could significantly affect pool elevations. In preparing this DEIS, a Notice of Intent was published in the Federal Register on February 26, 2007. A Scoping Letter was issued on April 9, 2007 to all known interested groups and individuals. A total of two comments were received in response to this notice. One comment was from a Utility and the second comment was from a Federal Agency. The concern was the environmental and human effect of significantly dropping the lake suddenly for a long period of time. The comments and Corps responses are included in Appendix C.

On completion of the DEIS, a Notice of Availability will be issued inviting public review and comment on the draft document during a 45-day review period. Comments will be considered and included in the final document. The Final Environmental Impact Statement (FEIS) will be circulated for public review and comment for 30 days. Additional comments will be considered and if there are no significant changes, a Record of Decision (ROD) will be signed, completing the NEPA process.

It should be noted that a DEIS for Wolf Creek Dam, which is also experiencing foundation seepage problems, is being prepared concurrently with this document. Both are continuing studies and any alternative selected is subject to being changed as new data becomes available or the situation requires.

1.6. Consultation and Required Permits. The Corps has the authority in an emergency to alter lake levels without observing the provisions of the regulations, but must consult with the agencies regarding alternative (after the fact) compliance arrangements. However, any other deviations to established operating levels require normal, full NEPA compliance, consultation and coordination with all relevant government agencies and obtaining any necessary federal, state, and local permits. Anticipated permits and other approvals include:

- National Pollutant Discharge Elimination System (NPDES) stormwater permits are being sought for the construction operations associated with the dam repairs described in previous NEPA documents, however, NPDES permits will not be required for altering lake levels.
- U.S. Army Corps of Engineers Section 404 procedures will not be required for altering lake levels.
- A Section 401 State Water Quality Certification or Aquatic Resources Alteration Permit has been obtained for construction activities associated with dam repairs described in previous NEPA documents; however, 401 Certification will not be required for altering lake levels.
- Air Quality is not affected by altering lake levels.
- National Historic Preservation Act – Section 106 review. Consultation with the State Historic Preservation Officer is currently underway. The degree of effect on cultural resources will depend on the lake levels that are finally decided upon. Drawdowns within the normal range of operations will require no action. Radical drawdowns will require additional consultation with the State Historic Preservation Officer and the implementation of historic property surveys.
- Section 7 – Endangered Species Act. The USFWS has agreed to be a cooperating agency. Informal Consultation has been initiated with the USFWS to determine what if any impact reduced lake levels may have on threatened or endangered species.
- Fish and Wildlife Coordination Act Report. A Fish and Wildlife Final Coordination Act Report has been requested from USFWS.
- Executive Order 11988 - Floodplain Management. Alternatives 1 has the potential of increasing the risk of a "base flood", but only in the event of a dam failure. All other alternatives increasingly reduce the risk of a "base flood" as the top pool elevation is lowered under each following alternatives.
- The Tennessee Valley Authority (TVA) has agreed to be a cooperating agency; however, a TVA 26a permit is not required for this action.

2.0 Alternatives

2.1. Description of Interim Pool Elevation Alternatives. Nine interim pool elevation alternatives (operating bands) have been developed out of safety considerations. During the 7 – 10 year dam repair period, it may be necessary to significantly lower the lake for an extended period of time to ensure a low risk of dam failure. As the structural integrity of the dam increases and risk of failure decreases during the repair period, it may be possible to raise Center Hill Lake incrementally to the Normal Operating Band. The goal of the dam repairs is to return to the status quo condition which is the Normal Operating Band. Alternatives include a No Action (Existing Operation Band), Full Fill (Normal Operating Band), Partial Fills, and Emergency Operating Bands (Table 2).

2.1.1. Alternative 1, Lake EL 648.0/623.5. This alternative would continue to optimize all of the authorized project purposes. This alternative would, however, do nothing to alleviate the risk associated with maintaining the pool at this elevation. This alternative would maintain the PMB and normal water management practices of capturing and storing winter and spring rains for later hydropower releases. No consideration to reduce stress on the dam foundations or minimize seepage flow would be attempted. Damages from dam failure were estimated at about $1.3 billion. Potential loss of life depends on many variables including the speed of dam failure, warning times, severity of the flood event, and the effectiveness of evacuation measures.

Under this alternative, the average maximum summer pool (EL 648) and average minimum winter pool (EL 623.5) would be maintained. At this elevation, winter and spring rains can quickly exceed the top of the power pool, particularly in a wet year, which would substantially increase the potential risk of dam failure. The failure could be slow, allowing time for a controlled release to empty the reservoir, or it could be sudden. A sudden dam breach failure would be catastrophic. In addition to the potential loss of lives, damages would be excessive and would entail severe disruptions throughout the Cumberland River Basin. Although this alternative is unacceptable, it will be evaluated throughout this document to provide a comparison of the other alternatives against the impact of unmodified pool operations.

In the emergency of severe dam foundation or rim stress, as determined by stress criteria listed in Section 1.3, the lake may need to be drawn down as quickly as possible to reduce the risk of dam failure. The lake would remain drawn down until the emergency has passed and the dam and rim walls can safely contain Center Hill Lake at these elevations.

It is assumed that Center Hill Lake would be returned to this operating band after repairs have been completed.

2.1.2. Alternative 2, Lake EL 645.0/623.5. This alternative would operate Center Hill at normal winter pool, but would only raise the top of the pool to EL 645, i.e., about 3 feet below the top of the power pool during the summer. These elevations would likely have a few minor impacts (Figure 6). Hydropower would lose some added water storage reserved for peaking hours. The hypolimnion would be slightly reduced resulting in less cold water storage for downstream water quality, fish, and coal fired power plants. This elevation would not significantly reduce hydrologic pressure or reduce the risk of dam failure, which would decrease protection to downstream populations.

Figure 6. Comparison of Interim Pool Elevation Alternatives and Impact to Project Benefits.

Alternative	Top Pool Elevation (ft)	Flood Damage Reduction			Hydro-power			Navigation			Recreation			Fish and Wildlife			Water Quality			Water Supply		
		Year *			Year			Year			Year			Year			Year			Year		
		T	D	W	T	D	W	T	D	W	T	D	W	T	D	W	T	D	W	T	D	W
1	648/623.5	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
2	645/623.5	None	None	None	None	Minor	None	None	None	None	None	None	None	None	None	Minor	Minor	Minor	None	None	None	None
3	640/623.5	None	None	None	Moderate	Moderate	Minor	None	Minor	None	Minor	Minor	Minor	Minor	Minor	Moderate	Moderate	Moderate	Minor	None	Minor	None
4	635/623.5	None	None	None	Moderate	Severe	Moderate	Minor	Minor	None	Minor	Minor	Minor	Moderate	Minor	Severe	Moderate	Moderate	Moderate	Minor	Minor	None
5	630/618	None	None	None	Severe	Severe	Moderate	Minor	Moderate	Minor	Moderate	Moderate	Moderate	Severe	Moderate	Severe	Severe	Severe	Moderate	Moderate	Moderate	Minor
6	625/623.5	Moderate	Moderate	Moderate	Severe	Severe	Severe	Moderate	Moderate	Moderate	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe
7	625/618	Moderate	Moderate	Moderate	Severe	Severe	Severe	Moderate	Moderate	Moderate	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe
8	622 (Flat-line)	Severe	Severe	Severe	Severe	Severe	Severe	Moderate	Moderate	Moderate	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Moderate	Severe	Severe	Severe
9	Emergency 618-496	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe

*** Study Year; Rainfall Conditions: T – Typical D – Dry W – Wet**

Negative Impact: None | Minor | Moderate | Severe

2.1.3. Alternative 3, Modified, Lake EL 640.0/623.5. This alternative is the current operating band which serves as the No Action alternative. Under this alternative lake elevations would be aggressively managed to follow the bottom of the PMB. Center Hill Lake would operate at the customary minimum (winter) pool (EL 623.5), and would only rise to EL 640, i.e., about 8 feet below the top of the power pool. These elevations would likely have some minor to moderate environmental and economic impacts (see Figure 6) which may be worse in dry years. Hydropower would lose some water storage reserved for peaking hours. The hypolimnion would be reduced resulting in less cold water storage for downstream water quality, fish, and coal fired plants. Recreation would be slightly impacted as shorelines are exposed and aesthetics are reduced. This elevation could reduce hydrostatic pressure and reduce the risk of dam failure and increase protection to downstream populations.

2.1.4. Alternative 4, Environmentally Preferred Alternative, Lake EL 635.0/623.5. Under this alternative, Center Hill Lake would operate at the customary minimum (winter) pool (EL 623.5), and would only rise to EL 635, i.e., about 13 feet below the summer recreation elevations to which the public has become accustomed. This top elevation appears to be a breakpoint where most authorized project purposes are still being met, albeit with some minor to moderate impacts depending on the year's rainfall (Figure 6). Hydropower would maintain peaking power capabilities except in a dry year. The hypolimnion would be moderately reduced but would contain enough cold water to support coal fired power plants, water supply, water quality, and a cold water fishery. Recreation would be slightly impacted as shorelines are exposed and aesthetics are reduced. A few boat ramps would no longer be useable. Water quality would be moderately to severely impacted. Poor water quality would, in turn, negatively affect water supply and the fisheries. The low water elevations could also impact fish spawning in the lake.

On the other hand, this elevation would reduce hydrostatic pressure and the risk of dam failure and would increase protection to downstream populations. Although normal operations would be favored, i.e., a return to a summer elevation of EL 648, this is the environmentally preferred alternative during the period of repairs because it represents a breakpoint below which the negative impacts suddenly change from predominately minor to moderate or severe yet it still relieves some pressure on the dam foundation. After repairs are completed the lake would once again resume “normal” operations between El623.5 and EL 648.

2.1.5. Alternative 5, Dam Safety and Engineering Preferred Alternative, Lake EL 630.0/618.0. This alternative would operate Center Hill between the bottom of the Congressionally authorized power pool (EL 618.0) and EL 630, i.e., about 18 feet below the summer recreation elevations to which the public has become accustomed. At this operating band virtually all project purposes except for flood control would be moderately to severely impacted (Figure 6). Even in a typical rainfall year, severe impacts would be seen for hydropower, fish and wildlife, and water quality needs. Many boat ramps would be unusable at various times of the year. At EL 620, all boat ramps would be unusable. Water quality, particularly DO and temperature would become major concerns, particularly in the tailwater. The fisheries both in the lake and in the tailwater would be stressed. Poor water quality together with algal and bacterial blooms would require additional processing by municipal water suppliers. Less cold water would be available for cooling fossil fuel electrical plants. Reduced water releases during a dry year could affect navigation with reduced water depth in the navigation channel. At EL 618 virtually all project purposes would be gravely impacted if not eliminated except that water supply would still be protected. The reduction of hydrostatic pressure and risk of dam failure would further reduce hydrologic pressure and reduce the risk of dam failure, which would increase protection to downstream populations. This alternative is preferred from a dam safety and engineering perspective as it provides a balance between sustaining some project uses while lending greater priority to safety. This band provides 12 feet of safe storage during flooding, and allows 12 feet of storage for downstream uses during a potential drought.

2.1.6. Alternative 6, Lake EL 625.0/623.5. This alternative would operate Center Hill at the customary winter pool elevation, but would only raise the top of the pool to EL 625, i.e., about 23 feet below the summer recreation elevations to which the public has become accustomed. The operating curve would be almost flat. At this operating band virtually all project purposes except flood control would be impacted (see Figure 6). Hydropower production would be impacted. Most boat ramps would be unusable. Water quality, particularly DO and temperature would become major concerns, particularly in the tailwater. The fisheries both in the lake and in the tailwater would be stressed. Poor water quality together with algal and bacterial blooms would require additional processing by municipal water suppliers. Less cold water would be available for cooling fossil fuel electrical plants. Navigation could be affected due to restricted water releases that may result in a reduced navigation depth once this elevation is met and maintained within this band. On the other hand, this elevation would reduce hydrostatic pressure and the risk of dam failure and would increase protection to downstream populations.

2.1.7. Alternative 7, Lake EL 625.0/618.0. This alternative would affect both normal summer and winter pool elevations to which the public has become accustomed. The top elevation is 23 feet below the customary summer pool (EL 648) and the bottom elevation is 6.5 feet below the customary winter pool (623.5). This alternative would allow water releases to support some of the downstream project uses. At this top elevation virtually all project purposes except for flood damage reduction would be impacted (see Figure 6). Significant impacts to hydropower, thermal power, recreation, navigation, fish and wildlife and water quality could occur. At EL 618 virtually all project purposes would be impacted if not eliminated except that water supply would still be protected. The reduction of hydrostatic pressure and risk of dam failure would further reduce hydrologic pressure and reduce the risk of dam failure, which would increase protection to downstream populations.

2.1.8. Alternative 8, Flat-line, Lake EL 622.0. Under this alternative, the pool would operate at this targeted pool elevation all year long to reduce hydrostatic pressure on the dam foundation. This elevation is about 1.5 feet below the customary winter pool (EL 623.5) and about 26 feet below the summer recreation elevations to which the public has become accustomed. Every attempt would be made to hold the lake steady at this elevation. This is the worst alternative available as it allows no flexibility in operation. During a storm event, all available outlets would be used to rapidly release water, without exceeding the downstream channel capacity, but slightly elevating flooding risks downstream. By the same token, if water is needed for some reason such as maintaining water quality, supporting thermal plants, maintaining navigation, or providing minimum flows in the tailwater for the trout fishery, it could not be released. At this elevation virtually all project purposes would be impacted (Figure 6).

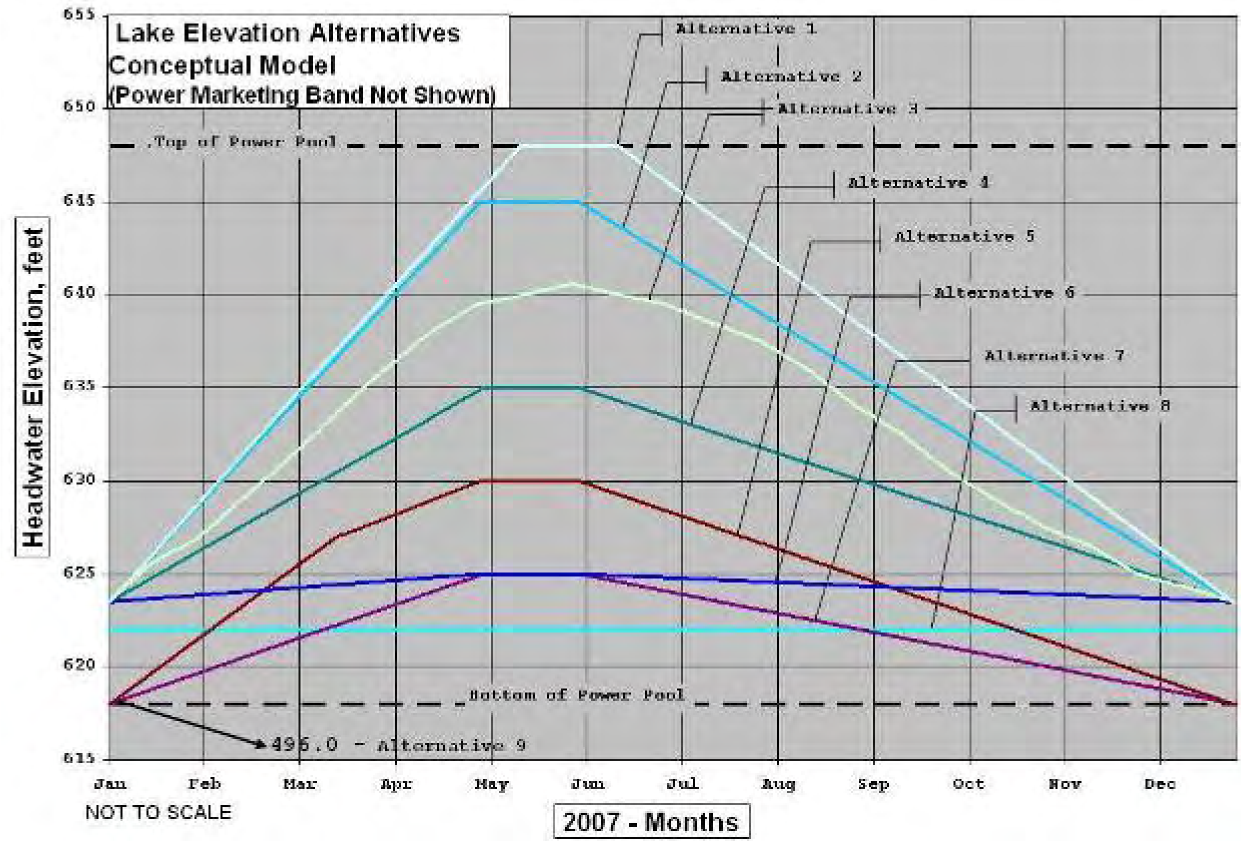
2.1.9. Alternative 9, Emergency Drawdown, EL 618.0/496.0. Under this alternative, Center Hill would operate below the bottom of the power pool. Attempting to generate hydropower at this elevation would likely damage the hydropower units. Water releases might be allowed to ensure downstream water supplies unless lowering the lake further jeopardizes upstream water supplies. Below this elevation, water can only be discharged through the sluice gates. During an emergency, every attempt would be made to hold the lake below this elevation. During a storm event, all available outlets would be used to release water, without exceeding the downstream channel capacity, but this action would elevate flooding risks downstream. At this elevation virtually all project purposes would be severely impacted if not eliminated.

Table 2. Interim Lake Elevation Alternatives for Center Hill Lake.

Pool Elevation Alternatives	Average Minimum Lake Elevations (ft)	Average Maximum Lake Elevations (ft)	Time of Maximum Lake Elevation
Alternative 1 Normal Operating Band	623.5	648.0	Full Fill – June
Alternative 2	623.5	645.0	Partial Fill - June
Alternative 3 Existing Condition	623.5	640.0	Partial Fill – June
Alternative 4 Environmentally Preferred	623.5	635.0	Partial Fill – June
Alternative 5 Dam Safety and Engineering Preferred	618.0	630.0	Partial Fill – June
Alternative 6	623.5	625.0	Partial Fill – June
Alternative 7	618.0	625.0	Partial Fill – June
Alternative 8	622.0	622.0	Flat-line – year round
Alternative 9	496.0	618.0	Emergency Drawdown

For Alternatives 1 - 4, and 6, lake levels start at the same elevation (EL 623.5) at the beginning of the year and are allowed to fill to a maximum elevation of EL 648.0, EL 645.0, EL 640, EL 635.0, and EL 625.0 respectively by June of that year. Alternative 4 is the environmentally preferred alternative. Alternative 5, the plan preferred for safety and engineering reasons, begins at 618 and is allowed to fill to a maximum elevation of EL 630. Alternative 7 would begin at EL 618 and would reach a maximum elevation of 625. Alternative 8 maintains the pool all year long at a flat-line elevation of 622.0. Alternative 9 would occur only under an emergency when the lake is emptied below EL 618.0 to a minimum EL 496, when the sluice gates would remain open to allow the Caney Fork River to flow freely through the dam. The anticipated operating curve for each pool elevation alternative is shown in Figure 7. This figure is not drawn to scale and is a *conceptual drawing* as depicted by the straight line operating curves. Once an alternative is selected, a detailed model will be used to refine the real-time operating curve. No matter what alternative is selected, elevations along the curve will be intimately tied to hydrologic conditions and system requirements at that specific date and time.

Figure 7. Average Maximum and Average Minimum Pool EL for Each Alternative.



2.2. Summary of Indirect and Cumulative Impacts.

Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the (proposed) action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions (40 CFR 1508.7)". Based on the public and agency scoping and review performed for the previous NEPA documents conducted for this project, the following resources were identified as target resources within the assessment goals: socioeconomics, water quantity, water quality, aquatic resources, threatened and endangered species, recreation/tourism, river navigation, and cultural and historic resources.

The ten multipurpose projects in the Cumberland River Basin are operated as a unified system. Water releases are coordinated among the projects to minimize flooding throughout the Cumberland River system. A reduced pool would directly affect project purposes at Center Hill and indirectly affect the system purposes of hydro and thermal power production, water quality, water supply, aquatic resources, endangered species, recreation, and navigation. The severity of impacts is related to rainfall year. A wet year would replenish water within the system, while a dry year would exacerbate problems.

Wolf Creek Dam is suffering similar problems that Center Hill is experiencing and has required lowering the storage of Lake Cumberland. Dale Hollow, Wolf Creek, and Center Hill Dams provide most of the water flow in the Cumberland River. Great demand would be placed on Dale Hollow Lake to store additional water early in the year and to release it throughout the dry periods to supplement the flow of the Cumberland River. Storage restrictions at Center Hill and Wolf Creek Dams could result in reduced water quantity in the Cumberland River.

The impacts of water storage (or lack thereof) could be felt to confluence of the Cumberland and Ohio Rivers. Without water storage at Wolf Creek and Center Hill Dam, the entire Cumberland River System has the potential to stagnate. The resultant low flows in the Cumberland River could affect electrical production at both hydro and thermal power plants, water quality, aquatic resources, threatened and endangered species, municipal water supply, economics, recreation, flood damage reduction, and navigation.

Electrical Power Production. TVA's Gallatin and Cumberland City steam plants rely on the water supply provided by the Cumberland River system for cooling water flow. The lack of storage in Center Hill would mean that there is less water available for release into the Cumberland River. If there is insufficient flow in the Cumberland River, then cool water may be unavailable to dilute the hot water discharged by the thermal plants. In addition, lack of water storage would mean that there is less water available for the hydropower plants to provide peaking power when it is most needed. Loss of hydro and thermal power production could result in brownouts or even blackouts if other sources of supply are insufficient.

Water Supply. The three water supply intakes on Center Hill are located below the bottom of the power pool (EL 618) and are unlikely to be affected. Nevertheless, if the lake experiences algal booms there could be taste and odor problems which would require increased water treatment costs. There is one intake about 19 miles downstream of the dam in the Caney Fork River tailwater. Under drought conditions, low flows could result in its forced closure.

Socioeconomics. Center Hill Dam and Reservoir has contributed to the regions socioeconomics by providing inexpensive hydropower, cooling water for thermal power plants, reliable water supply, recreation, flood damage reduction, and to a limited extent it has aided in navigation and inexpensive transportation of goods. The lower Center Hill pool is maintained, the less water is stored to meet these demands. Each of these uses would be negatively affected to a greater or lesser degree depending on the lake storage level attained and the amount of rainfall.

Water Quality. Good water quality is a key to Center Hill Lake supporting all its designated uses. Lower lake levels and less storage capacity could result in poorer water quality not just in the Caney Fork tailwater, but throughout the entire downstream length of the Cumberland River to its confluence with the Ohio River. Municipal and commercial water suppliers would face greater treatment costs and up to seven Federally listed endangered or candidate mussel species could be affected. Discharges from Center Hill Dam could violate state water quality standards for a trout stream classification. There are water quality concerns within the Center Hill Lake as well. High nutrient levels from runoff into the lake from some agricultural areas and waste water plants are cause for concern at times. As the lake level drops, hydraulic residence time could increase as less water is released. Nutrients could concentrate, resulting in algal blooms. Algal die-offs deplete dissolved oxygen, resulting in the potential for fish kills. Under drought conditions, and a very long retention time, lake water quality could worsen without the addition of fresh rain water.

Aquatic Resources. As noted above, water quality becomes poorer if there is insufficient stored water in the Center Hill reservoir. Poor water quality directly affects aquatic organisms. Under worst-case circumstances low DO and higher temperatures would add stress to fish and mussels. Poor conditions could also trigger algal and bacterial blooms which would further distress the ecosystem. Fish and mussel kills could be anticipated. Major die-offs would negatively affect recreation which, in turn, would affect the economy. However, water quality mitigation measures discussed in Section 2.4, below would address these potential impacts.

Flood Damage Reduction. Allowing the dam to be lost by failing to effect repairs would be catastrophic for downstream populations. An unintended side effect of maintaining a reduced pool to alleviate pressure on the dam's foundation is that it would actually create additional flood storage capacity and would temporarily increase flood protection. The primary difference is that the captured flood waters would be evacuated as quickly as possible instead of the current practice of releasing them so as to optimize their potential uses.

Recreation. During the 7-10 year dam repairs, recreation on Center Hill Lake would be negatively impacted. Depending on the elevation selected, all of the boat ramps could become unusable, all of the marinas could be impacted and at least one marina may be closed, and half of the private docks could be inaccessible. As fishing conditions declined, so too would recreation. Access to the lake would be highly restricted resulting in economic hardship for the local economy. Though the effects would be temporary, it could take years to recoup the financial losses. Safety concerns would also increase as navigation hazards (submerged logs, rocks, shallow gravel bars) develop in Center Hill Lake.

Navigation. Navigation is not a project purpose at Center Hill. However, under normal operations, tailwater releases augment flow in the Cumberland River to aid navigation. During repairs, tailwater flow would be restricted, providing little water to the system. A nine-foot commercial navigation channel on the Cumberland River upstream of Barkley Dam is generally supported by the maintenance of full, flat pools at the four main-stem dams. If the customary releases from Wolf Creek and Center Hill are not available, the Corps' ability to maintain the nine-foot channel may be compromised. This would, in turn, affect transportation costs and the economy.

2.3 Unavoidable Adverse Effects. Although all of the interim pool elevation alternatives carry some risk of dam failure, this risk is reduced with each successive alternative. Alternatives 1 and 2 carry the most risk because of the high hydrostatic pressure placed on the dam. This risk is significantly reduced under Alternative 3 (Current operating band) and is increasingly reduced under Alternative 4 to Alternative 8. Under Alternative 9, Center Hill Lake would be drained, which would ensure no risk of dam failure. However, as each successive alternative reduces the risk of failure, it also detracts from the authorized project purposes and increases negative impacts on several important resources. The goal of this DEIS is to select an alternative that balances safety against the loss of project purposes the impact to those resources. Lowering and maintaining a reduced pool would have negative effects on hydropower, water supply, recreation, water quality, fish and wildlife management, threatened and endangered species, and navigation. Under the worst case scenario hydropower production would be foregone, thermal power plants could be de-rated due to lack of cooling water, recreation would decline as boat ramps and marinas were closed, navigation would be reduced, water quality would decrease to the point of violating state water quality standards, Federally listed threatened and endangered species would be stressed and some could be lost, algal blooms and fish kills would increase, water treatment costs would increase, and the economy would be impacted. The actual severity of the impacts would depend on a number of factors including the chosen level to be maintained, weather including rainfall and temperatures, and conditions at other lakes within the Cumberland River Basin. Some would be greatly minimized by water quality mitigation measures to be employed. Theses negative short-term affects are unavoidable, but considered prudent when weighed against the risk of dam failure.

2.4 Mitigation Measures Negative environmental impacts are to be avoided wherever and whenever possible. When they can not be avoided, they must be minimized. Compensation must be made for impacts that can not be avoided or minimized. It may be possible to avoid or minimize impacts by installing structural features on dams, or changing system operations. These following discretionary measures have been developed for consideration by the U.S. Army Corps of Engineers as actions that could be undertaken by the Nashville District as reasonable and prudent measures. However, in order for mitigation to be undertaken, the District must have both authority and appropriations to perform any proposed mitigation.

2.4.1 Measure No. 1. Installation of an Orifice Gate Over a Sluice Gate. In 2004 the Corps Conducted a study titled Center Hill Tailwater Modeling for Minimum Flow Evaluation that found the optimum minimum flow below Center Hill is about 200 cfs. Even a single sluice gate far exceeds this volume (about 1,500 cfs) and it often exceeds the inflow into the lake. To provide minimum flow the Corps has tried pulsing the flows through a single sluice gate with unsatisfactory results. The flow is too much to be sustained and the slope of the river bed rapidly drains the discharged water so that frequent pulsing is required. One solution may be installing an orifice gate over a sluice gate. The orifice gate would limit the discharge to a constant 200 cfs, providing a constant minimum flow with high levels of DO. This would benefit both the tailwater and the upper end of Old Hickory Lake.

2.4.2 Blending Turbine and Sluice Gate Discharges. The average discharge of water from a turbine at Center Hill is between 3,500 and 4,000 cfs depending on the lake level. During the warmer months of the year, i.e., roughly May through October, the water stratifies and virtually all DO in the deeper portions of the lake is consumed by ongoing chemical and biological processes. Consequently, water discharged through the turbines is very low in DO and the tailwater ecology suffers. In recent years the Corps has been experimenting with releases through the sluice gates to compensate for this problem. Water discharged through the sluice gates can have as much as 10 mg/l of DO. Each of the six sluice gates can discharge about 1,700 cfs. Thus, when generation is required during the warmer months a sluice gate can be opened and as the waters from the turbines and the sluices blend adequate DO is achieved. This would benefit both the tailwater and the upper end of Old Hickory Lake.

2.4.3 Supplemental Flows from Other Tributary Lakes. It may be possible to store some excess water in Dale Hollow and/or J. Percy Priest Lakes early in the year and slowly release this water over the summer to mitigate for the reduced flows from Center Hill. This course of action would be dependent on several factors including the amount of rainfall and several operational factors. This was done to a limited extent in 2007 when Dale Hollow was filled to about EL 653, or approximately two feet above the top of the power pool. This action would have to be planned and approved in advance to make any significant difference.

2.4.4 Spill vs. Generation. As noted above, the preferred method for regulating lake levels is by hydropower generation. However, during the summer months when water quality in the mainstem lakes typically decreases, the Corps has occasionally resorted to spilling water through the mainstem tainter gates rather than by generating because this increases the DO in the tailwater where most of the species of concern are likely to be found. The disadvantage of this, of course, is the power lost by foregoing hydropower generation. Center Hill can only discharge water through its flood gates when the pool is in flood stage, i.e., above EL 648.0. This form of mitigation would not, therefore, apply to Center Hill or any of the upstream tributary lakes. But it can apply to the lock and dam projects on the mainstem of the Cumberland River.

2.4.5 Recreation Improvement. Where practicable, boat ramps would be extended to allow access to the lake. Marinas would be allowed to re-configure and/or relocate to more suitable areas.

2.5 Comparison of Alternative Pool Elevations and Resource Impacts. Impacts are most notable during the summer months when demands on project uses are the greatest. Additional impacts occur when the lake is dropped below the customary winter pool (EL 623.5). Based on historical operations, the range of conditions that may occur to project uses as the lake is operated under each alternative can be predicted (Figure 6). Table 3 compares the impact each alternative would have on important resources. It is important to note that Alternative 1 represents the normal operating band under normal conditions. Only in the event of a dam failure, the impact to important resources would be severe under Alternative 1, and moderate under Alternative 2. Studies have shown that maintaining a high summer pool increases the risk of dam failure until such time repairs are complete enough to support the hydrostatic pressure without loss of dam integrity. It is expected that in the event of a dam failure, the lower the pool elevation the lower the flood damage downstream. Table 3 provides an indication of the impact to important resources under each interim pool elevation alternative. The dash line indicates no significant impact to that resource.

Table 3. Comparison of Interim Pool Elevation Alternatives and Negative Impact to Resources.

Environmental and Economic Impacts	Alternative 1 Normal EL 648/623.5	Alternative 2 Lower Pool EL 645/623.5	Alternative 3 Lower Pool Current Condition EL 640/623.5	Alternative 4 Lower Pool Environ-mentally Preferred EL 635/623.5	Alternative 5 Lower Pool Safety & Engineering Preferred EL 630/618	Alternative 6 Lower Pool EL 625/623.5	Alternative 7 Lower Pool EL 625/618	Alternative 8 Flat-line EL 622	Alternative 9 Emergency EL 540/496
Safety	Severe	Severe	Severe	Moderate	Moderate	Minor	Minor	Minor	-
T & E Species	-	-	Minor	-	Moderate	Moderate	Moderate	Severe	Severe
Aquatic Resources	-	-	Minor	-	Moderate	Moderate	Moderate	Severe	Severe
Coldwater Fishery	-	-	Minor	Minor	Moderate	Severe	Severe	Eliminated	Eliminated
Water Quality	-	-	Minor	Moderate	Severe	Severe	Severe	Severe	Severe
Wildlife Resources	-	-	-	Moderate	Moderate	Moderate	Moderate	Moderate	Severe
Wetland Impacts	-	-	-	-	-	-	-	-	-
Water Supply	-	-	-	Minor	Moderate	Minor	Moderate	Severe	Severe
Historic Properties	-	-	-	-	-	Minor	Minor	Moderate	Severe
Low Water Flow	-	-	Minor	Moderate	Minor	Severe	Severe	Severe	Severe
Increased Tailwater Heights	-	-	Minor	Moderate	Moderate	Severe	Severe	Severe	Severe
Shoreline Erosion	-	-	Minor	Minor	Moderate	Severe	Severe	Severe	Severe
Environmental Justice	-	-	-	-	-	-	-	-	-
Recreation	-	-	Minor	Minor	Moderate	Severe	Severe	Severe	Severe
Aesthetics	-	-	Minor	Minor	Moderate	Severe	Severe	Severe	Severe
Air Quality	-	-	-	-	-	-	-	-	-
Noise	-	-	-	-	-	-	-	-	-
HTRW	-	-	-	-	-	-	-	-	-
Flood Control	-	-	-	-	Minor	Moderate	Moderate	Severe	Severe
Hydropower	-	-	Minor	Minor	Moderate	Severe	Severe	Severe	Eliminated
Thermal Power	-	-	Minor	Minor	Moderate	Severe	Severe	Severe	Severe
O & M Costs	-	-	-	Minor	Moderate	Severe	Severe	Severe	Severe
Economics	-	-	-	Minor	Moderate	Severe	Severe	Severe	Severe
Traffic	-	-	-	-	-	-	-	-	-
Navigation	-	-	Minor	Minor	Moderate	Moderate	Moderate	Moderate	Severe
Man-made Resources	-	-	-	-	-	-	-	Moderate	Moderate
Public Facilities	-	-	-	Minor	Moderate	Severe	Severe	Severe	Eliminated
Public Services	-	-	-	Minor	Moderate	Severe	Severe	Severe	Severe
Employment	-	-	-	-	Minor	Moderate	Moderate	Severe	Severe
Tax Values	-	-	-	-	Minor	Moderate	Moderate	Severe	Severe
Property Values	-	-	-	-	Minor	Moderate	Moderate	Severe	Severe
Community Cohesion	-	-	-	-	Minor	Moderate	Moderate	Severe	Severe
Displace People	-	-	-	-	Minor	Moderate	Moderate	Severe	Severe
Displace Businesses	-	-	-	-	Minor	Moderate	Moderate	Severe	Severe
Farms	-	-	-	-	Minor	Moderate	Moderate	Severe	Severe
Disrupt Community Growth	-	-	-	-	Minor	Moderate	Moderate	Severe	Severe
Disrupt Regional Growth	-	-	-	-	Minor	Moderate	Moderate	Severe	Severe

- = No Significant Effect

2.6 Conclusions. One purpose of this study is to attempt to identify a level or operating band at which all concerns, including safety, are recognized. All of the alternatives have their own individual benefits and drawbacks. Alternative 1 optimizes the authorized project purposes. The tradeoff, however, is that it also carries the greatest risk of dam failure. Alternatives 2, 3, 4, and 6 all begin with the same minimum pool elevation as Alternative 1, but they each show an incremental decrease in the maximum allowable pool elevation. As the maximum pool decreases, so too does the risk of dam failure, but at the cost of increasing impact to resources. Alternative 4 represents a breakpoint below which the negative impacts suddenly change from predominately minor to moderate or severe. Alternative 4 is, therefore, considered to be the environmentally preferred alternative. Alternative 5 is preferred from a safety and engineering perspective. Alternative 7 is less preferred because of the severity of impacts. Alternative 8, Flat-line, represents the worst of all possible alternatives as it offers no flexibility in operating the system. Alternative 9 represents an emergency drawdown during which every available method of drawing down the lake would be used to prevent a catastrophic failure.

3.0 Affected Environment (Baseline Conditions)

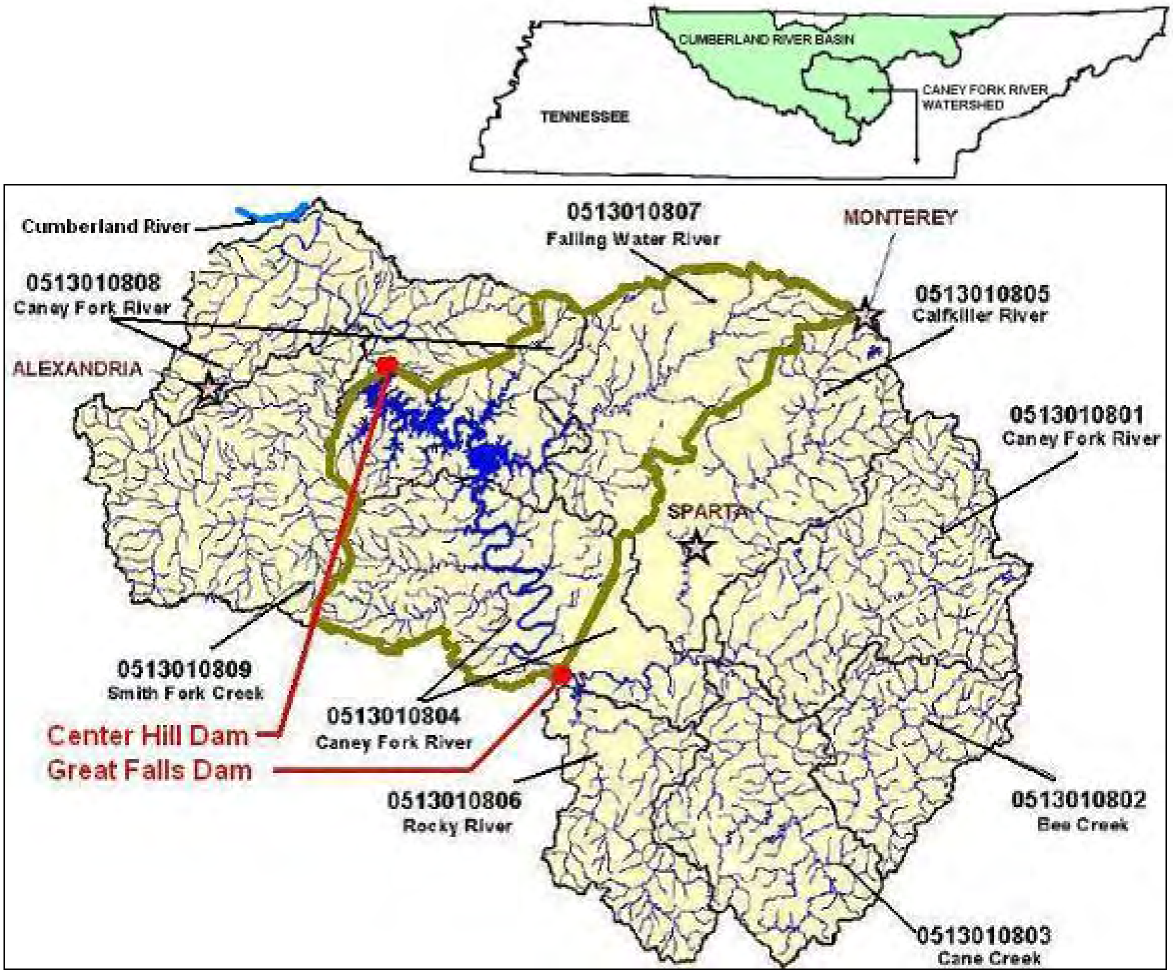
The proposed project area for pool elevation alternatives is located at Center Hill Dam and Lake. The impacts of altering pool elevations below the established PMB band have consequences that reach far beyond the immediate lake. River flows, water quality, dissolved oxygen, water temperature, and economics, just to name a few, would be impacted throughout the length of the Cumberland River Valley. This section describes the physical, biological, social, historic property, and economic resources in the Cumberland River Basin that could be affected.

3.1. Environmental and Physiographic Setting. The climate of the area is distinctly continental with moderate temperatures averaging about 60 degrees Fahrenheit and rarely exceeding 100 degrees Fahrenheit or falling below zero. The length of the average growing season is about 210 days, extending from early April to the end of October. Annual precipitation for the basin averages 45 to 50 inches.

The dam lies within Ecoregion 71, the Interior Plateau, (EPA Ecoregions 2004). Ecoregion 71 varies from mountainous areas in the eastern sections to rolling plateau, undulating plains and hills in karst terrain. Deep, narrow valleys through which creeks and rivers flow cut the area. Near the Cumberland River steep bluffs, springs, cascades, and wide bottomlands occur. The bedrock of the basin is Paleozoic Age with sandstone, limestone, shale, coal, and conglomerate members. The natural vegetation is primarily oak-hickory forest. Streams have a moderate gradient with productive, nutrient-rich waters. Rainfall averages between 48 and 56 inches per year.

The Caney Fork watershed covers nearly 2,174 square miles. The Caney Fork River Watershed is identified by the U.S. Geological Survey (USGS) with an 8-digit Hydrologic Unit Code (HUC05130108). Because of the large size of the 8-digit HUC watersheds, USGS worked with the U.S. Department of Agriculture, Natural Resource Service (NRCS) to divide the watershed in to smaller units of 10-digit HUC watersheds. The advantage of dividing the watershed this way, is that drainage patterns can be easily seen and all water draining into a specific areas like Center Hill Lake, can be separated from streams draining into other areas of the watershed. In addition, large rivers, like the Caney Fork, can be divided into several pieces that have the same name, but different 10-digit HUC numbers (Figure 8). About one quarter of HUC0513010804, all of HUC0513010807, and nearly half of HUC0513010808 drain into Center Hill Lake. Roughly half of HUC0513010808 and all of HUC0513010809 drain directly into the Caney Fork River below Center Hill Dam. The rest of the Caney Fork Watershed (approximately one third) drains directly into Great Falls Reservoir on the Caney Fork River mile 91.1 (Figure 8). This DEIS covers detailed information on landuse, landcover, soils, permitted dischargers, and nonpoint pollution sources in HUCs that drain directly into Center Hill. Refer to TDEC's Caney Fork Watershed Plan to see detailed information for the entire Caney Fork River watershed.

Figure 8. Caney Fork River Watershed in Tennessee. TDEC 10-digit HUC codes denoting drainage patterns into Great Falls Reservoir, Center Hill Lake, and into the Caney Fork River below Center Hill Dam.



Most of the remaining agricultural land not inundated by the lake, lies on top of the plateau, although historically even relatively steep hillsides were cleared and farmed. Virtually all lands suitable for farming in the river valleys have been utilized for agriculture since settlement in the early nineteenth century, although farming many of the hillsides by modern mechanized methods would be impractical. The hills too steep for cultivation or pasture were allowed to remain forested, and the usable timber on them has been harvested periodically. Early commercial uses of the Caney Fork and Cumberland Rivers were for transportation of merchandise by boat, and floating log rafts to downstream markets.

Figure 9 - Cumberland River System of mainstem and tributary reservoirs.

<u>3.2. Hydrology and the Cumberland River Reservoir System</u>. The Cumberland River Basin covers about 17,700 square miles that spans Kentucky and Tennessee. While the total quantity of water within the Cumberland Basin can be estimated, that water is distributed unevenly. Precipitation is the major influence. Rain Storms can develop anywhere in the basin. However, the effect on river flow will depend on location, duration, intensity, season, and timing. An unregulated flow could result in severe flooding and high flows, or drought and very low flows. In order to minimize the extreme flow conditions, the hydrology of the basin was altered to a regulated system consisting of 10 Corps dams (Figure 10). Dams are common structures used to alter the natural flow of water through the landscape and are generally built to store water for flood damage reduction, hydroelectric power generation, industrial cooling, potable and industrial water supplies, recreation, water quality, fish and wildlife needs, and navigation. When dams are built, they alter the structure of a river system, causing it to change from a river (free flow) to lake (static) and tailwater discharge (regulated flow). This alteration changes the flow patterns and flow timing of a river system, which can affect water quantity, quality, sediment transport, and habitat upstream and downstream of a dam (EPA 2007). Where dams are part of a larger river basin, cumulative impact assessment considers how the human and environmental impacts of one dam are related to the same impacts of other dams and other water management operations within a river basin.

The system approach allows water to be stored or withdrawn anywhere in the system to equalize velocity and depth throughout the mainstem of the Cumberland River. Consequently, any one or combination of dams could be drawn to ensure a consistent river flow. Storing water provides a great advantage during drought or flooding by minimizing the impact of the climatic event.

Center Hill is an integral part of the coordinated system to manage water quantity and quality for flood protection in the Cumberland and Ohio River Valleys. Impoundment of the Caney Fork River by Center Hill Dam changed the river from a free flowing stream to an impoundment (static reservoir), and regulated river downstream of the dam. The change in flow pattern affects water quantity, water quality, riparian, and aquatic habitat, and aquatic communities above and below the dam. These changes also affect the Cumberland River system.

The Corps constructed and operates ten dams and reservoirs within the Cumberland River Basin (see Figure 4). These dams were authorized and constructed at different times for different purposes. Barkley, Cheatham, Old Hickory, and Cordell Hull Dams are located on the mainstem of the Cumberland River with navigation locks that cumulatively, provide 452 miles of navigation from the mouth of the Cumberland River up to Celina, Tennessee. In addition to navigation, Barkley Dam has large water storage capacity of greater than one million acre-feet. Wolf Creek Dam is considered a tributary lake. It spans the Cumberland River, does not permit navigation, and also has a large water storage capacity in excess of one million acre-feet. The other Cumberland River tributary dams are Martins Fork Dam on Martins Fork in the headwaters of the Cumberland River, Laurel Dam on the Laurel River; Dale Hollow Dam on the Obey River, Center Hill Dam on the Caney Fork River, and, J. Percy Priest Dam on the Stones River. Besides Barkley and Wolf Creek, Dale Hollow, and Center Hill Dams are the only other projects that have a water storage capacity of greater than one million acre-feet.

The 10 projects are managed as a single system with the goal of managing the flow of water through the entire Cumberland River basin. This system drains parts of Kentucky and Tennessee. This systems approach manages the Cumberland River flow to be held or released at different projects depending on climatic conditions within the river basin. During floods, water is stored and time released to minimize damage downstream. During typical and dry years, water releases are coordinated to ensure enough water to meet downstream needs.

Under normal conditions, only three dams sustain the desired Cumberland River flows through Barkley Dam during drought. Wolf Creek, Dale Hollow, and Center Hill Dams supply 69%, 15%, and 16% of the total flow in the Cumberland River system respectively. The ability of a project to contribute flow to the system is linked to the summer pool storage elevation and the corresponding storage volume maintained at a Wolf Creek, Dale Hollow and Center Hill projects.

Currently Wolf Creek Dam is under repair and can not supply 69% summer storage water to the system. Wolf Creek is maintaining a flat-line elevation of 680. This increases the pressure for Dale Hollow and Center Hill to supply summer storage water to the system. How much water Center Hill would be able to store and release to the system would be dependant on the alternative selected.

Center Hill Dam is the second largest storage dam and a major contributor to the Cumberland River system. At the top of the flood control pool (EL 685), Center Hill's reservoir extends 64 miles upstream and covers 23,060 acres. The water's normal residence time is approximately 130 days. Center Hill Dam's tailwater extends 26.6 miles to the junction of the Cumberland River and backwater of Old Hickory Lake at Cumberland River Mile 309.2, just over four miles below Cordell Hull Dam. Center Hill tailwater traverses almost 107 miles to Old Hickory Dam (CRM 216.2) and its impact is felt much farther downstream.

3.3. Water Quantity. Center Hill is considered a high-head, long-term, storage dam with a large, deep pool (reservoir), long detention time, and a control over the volume of water released from the impoundment. Storage dams are designed to hold stormwater to prevent flood damage downstream. In addition, the large amount of stored water directly and incidentally supports many uses like hydroelectric power generation, municipal and industrial water supply, irrigation, fish and wildlife, recreation, water quality, navigation (EPA, 2007) and waste assimilation.

The large quantity of stored water in Center Hill reservoir simulates a deep lake. The pool undergoes processes such as thermal stratification, seasonal turnover, chemical cycling, and sediment storage. These processes occur primarily as a result of the presence of the dam creating the reservoir, not the operation of the dam. Most effects from dams are manifested downstream. (EPA, 2007).

3.4. Water Quality. The Center Hill Lake water quality can be described as good, even though it has some dissolved oxygen (DO) and nutrient problems. The mean lake depth is about 73 feet and mean retention time is about 130 days. In the past, the lake metalimnion (cool water layer several feet below the surface of the lake, with decreasing temperature and DO) contained so little DO that few cool water fish species were present in the lake. This situation typically occurs during the summer months, when this low oxygen, cool water band can be as much as 50 feet thick. High nutrient runoff into the lake from agricultural areas, and waste water plants are cause for concern at times. Major wastewater discharges into the lake are from the cities of Cookeville, McMinnville, Smithville and Sparta. It is not unusual for outflow (discharge below the dam) DO to fall below 5.0 mg/l and even approach 3.0 mg/l during the September and October low flow period. Outflow temperatures are relatively cold, ranging between 8º C to 14º C (46 º to 57 º F), which is somewhat predictable for a deep storage reservoir. The lake is temperature stratified from May through the fall months (Manual, 1998).

Lake Stratification. Retention time varies with pool volume and amount of inflow and outflow. Deep reservoirs such as Center Hill Lake undergo thermal stratification during the warmest six months of the year, from mid-Spring to mid-Fall. Thermal stratification is a natural lake effect (EPA, 1993). During this time, the pool divides into 3 layers: the epilimnion (top, warm water with high DO), the metalimnion (middle, cool water with decreasing temperature and DO), and the hypolimnion (bottom, cold water with low DO). The impacts of water quality outflows below a dam are an outcome of the seasonal temperature fluctuations and the location of outflow outlets (EPA, 2007).

High pool elevations ensure a large hypolimnion with lots of cold water volume for downstream use. Low pool elevations reduce the volume of the hypolimnion. Unlike lakes, reservoirs usually release water from the hypolimnion, as this is often the location of the turbine inlet. Center Hill Dam normally releases water during power generation from elevation 540, however the turbine withdrawal zone can extend considerably above this elevation depending on the magnitude of the releases. If the pool level is low, some warmer water above the hypolimnion is drawn into the turbines and released below the dam.

Center Hill Dam releases are generally cold due to the cold hypolimnetic withdrawal. Dam release temperatures can also be influenced by rainfall condition (wet, typical or dry years). During a dry year with low pool elevations, a warm tropical storm can add a high inflow of warm water, which must be evacuated and can flush out the hypolimnion.

In mid- to late fall the lake undergoes a turnover due to cooling of the lake surface, which eventually mixes the pool to create a uniform water quality and chemistry throughout the lake. During this time, temperature and dissolved oxygen requirements can be met downstream, even at normal winter pool elevations. The lake remains in a well-mixed state until mid-Spring when air temperatures warm the water surface, and stratification begins to occur again.

<u>Temperature and Dissolved Oxygen</u>. During the period when the lake stratifies, depletion of dissolved oxygen occurs below the epilimnion in the major tributary embayments. In the main channel of the reservoir, temperature and dissolved oxygen decrease in the metalimnion (thermocline) and is depleted in the hypolimnion of the reservoir. Dissolved oxygen levels are usually too low to sustain most fish and invertebrate life in the hypolimnion.

The extent of changes in downstream temperature and dissolved oxygen from reservoir releases depends on the retention time of water in the reservoir and the withdrawal depth of releases from the reservoir. Long residence time allows greater solar radiation absorption into the epilimnion, extending its depth. Reservoirs with short hydraulic residence times have reduced impacts on tailwaters. Storage reservoir releases are usually colder than inflows. The outflow temperature is usually sufficient for cold-water fish, even with warm inflows (EPA, 2007). The consequence of impoundment replaced the native warmwater fishery and freshwater mussels, including a number of now endangered mussel species, downstream of the dam with a coldwater fishery dominated by rainbow trout.

“Some impacts downstream can be perceived as beneficial to some and negative to others. For example, when water released from a dam is cooler than water downstream and it causes the downstream system to become colder, trout might relocate to this new habitat and displace native warm water species. Although increased trout is viewed by some as a positive effect, displacing native species may not be perceived as beneficial to others.” (EPA, 1993).

<u>Nutrients</u>. Reservoirs, like lakes, can be classified on nutrient content. Reservoirs with low, medium, and high nutrient content simulate oligotrophic, mesotrophic, and euthrophic lakes respectively. However, reservoir water quality reflects the watershed it drains. Under normal conditions, the large volume in the reservoir naturally dilutes and recycles nutrients. As pool volume drops, nutrients are concentrated. With a long retention time, nutrients exert a

biological oxygen demand (BOD) and use up the dissolved oxygen contributing to a large layer of anoxic water (hypolimnion) behind the dam. According to TDEC's Caney Fork Watershed plan, there are 21 sewer treatment plants in the Caney Fork watershed. Only 3 sewage treatment plants discharge directly into the Caney Fork River below the dam. Eight discharge into Center Hill Lake watershed, and 10 discharge upstream of Great Falls Dam, which discharges flow into Center Hill Lake. Industrial discharges can exert a chemical oxygen demand (COD) and use up the dissolved oxygen contributing to anoxic conditions in the hypolimnion behind the dam. There are a total of 48 industrial discharges in the Caney Fork watershed (TDEC, 2002). Seven discharge downstream of Center Hill Dam, 24 discharge into the Center Hill Lake watershed, and 17 discharge upstream of Great Falls Dam (TDEC, 2002). Nonpoint sources of nutrients include cattle, chicken, hog and sheep farming within the Caney Fork River watershed. Without adequate dilution, these nutrient and industrial sources contribute to oxygen demand in the hypolimnion of Center Hill Lake.

Pathogens, such as *E. coli*, are associated with high nutrient loading. In 2005, a Total Maximum Daily Load (TMDL) for pathogens in the Caney Fork River watershed was completed. The purpose of the TMDL was to determine the allowable pollutant load that streams can assimilate before violating water quality standards. A number of streams in the Caney Fork River watershed are listed on Tennessee's 2006 303(d) list as not supporting recreation use due, in part, to discharge of pathogens from sewage treatment plants, pasture land runoff, livestock in the creeks, and sewage collection system failure. The listed streams are Hickman, Fall, Hudgens, Pigeon Roost, and Mine Lick Creeks. Hickman flows into the Caney Fork River downstream Center Hill Dam. The other four creeks flow into Center Hill Lake. The TMDL establishes allowable loadings of pathogens to reduce in-stream concentrations enough to meet state water quality standards. The TMDL determined that pathogen loading needed to be reduced between 43-88% in the listed streams (TDEC, 2005).

Land usage in the drainage basin above Center Hill Lake consists of forestry, mining, agriculture, urban, industrial, and recreational uses. Runoff from these land uses directly affects the water quality of the lake. Mining, agriculture, and urban development in particular contribute nutrients that affect the oxygen requirements in the lakes. Like all reservoirs, Center Hill Lake can be expected to undergo future nutrient loading that will ultimately decrease the available dissolved oxygen in the tailwaters. The long-term status of all tailwaters will depend on engineering solutions to improve water quality as human development continues to degrade water quality in the watershed upstream (TWRA, 2006).

3.5. Tailwater Releases. Under normal operating conditions, with the exception of low dissolved oxygen during the stratified periods, the quality of the releases flowing through the Center Hill tailwater is good since this water is largely drawn from winter stored water from deep in the reservoir. This water is cold and low in dissolved and settleable solids, however, the released water can be low in dissolved oxygen in the summer through early fall. There are no known pollutants in the releases.

According to the Center Hill Lake Water Management Manual (1998), water quality needs are a primary consideration during the normally dry portion of the year, June through October. Old Hickory Dam is considered the water quality control point for Cumberland basin system operations. Generally, when desirable dissolved oxygen conditions in releases from Old Hickory are maintained, acceptable water quality conditions within the Cumberland River system are assured. The Tennessee water quality standard for dissolved oxygen (warmwater fishery) is a minimum of 5.0 mg/1. The estimated bi-weekly minimum average flow needed below Old Hickory to meet this DO requirement is presented in Table___. The 10-year average monthly discharges from Old Hickory are presented for comparison. These flows are calculated in cubic feet per second (cfs). In September, higher flows may be needed until Old Hickory destratifies.

Table 4. Old Hickory Tailwater Releases.

Month	Estimated Bi-Weekly *Minimum* Flow (cfs)	Ten year Average Monthly Discharges (cfs)
April	2,000	23,263
May	4,900	19,250
June	7,600	16,875
July	9,100	12,434
August	9,400	12,637
September	7,400	10,518
October	2,000	8,948

Actual flow requirements during a specific year may vary significantly from these numbers since they are influenced by hydrologic conditions and the Cumberland River system requirements to move water through the basin. Since there is no significant storage capacity at Old Hickory to supply such flows, releases from the upstream storage projects, including Center Hill, would be used to meet this need. At times, particularly during the summer months, water in Old Hickory and Cheatham Lakes can become stagnant and suffer from low dissolved oxygen (DO) and elevated water temperature. Water released from Center Hill Dam helps to reduce the water temperature and DO problems in the Cumberland River system (Corps, 1998).

3.6. Aquatic Resources. Lake Fishery**.** Prior to impoundment, the Cumberland and Caney Fork Rivers supported highly diverse assemblages of fish and aquatic life. Fisheries managers often refer to upper reaches of similar streams as smallmouth-rock bass streams. The lower river reaches graded into the "warm water" stream types. Since no aquatic survey data is available prior to the construction of dams, we must extrapolate from surveys of similar rivers.

Streams like the historic rivers mentioned characteristically had game fish species, smallmouth bass (*Micropterus dolomieu*) and spotted bass (*Micropterus punctulatus*) in its upper reaches and largemouth bass (*Micropterus salmoides*) occupying the warmer lower reaches. Panfish would include rockbass (*Ambloplites rupestris*), white crappie (*Pomoxis annularis*), longear sunfish (*Lepomis megalotis*), bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), warmouth (*Lepomis gulosus*), and various sunfish hybrids, channel (*Ictalurus punctatus*), flathead (*Pylodictis olivaris*), and bullhead (*Ameiuris spp.*) catfish. The list of pre-impoundment fish would include many other species such as minnows and shiners (*Cyprinidae spp.*), darters (*Percidae spp.*), sculpins (*Cottidae spp.*), various members of the sucker family (*Catostomidae spp.*), and probably some uncommon species.

Center Hill Lake supports good cool and warm water fisheries. Weekly fishing reports are provided on the TWRA, Region 3 website. Depending on season, a variety of fish species are caught including walleye (*Stizostedion vitreum*), sauger (*Stizostedion canadense*), bass (largemouth, smallmouth, and spotted), catfish, bluegill, and to a less extent, white bass (*Morone chrysops*) and striped bass (*Morone saxatilis*). The best fish are caught along the main lake bluffs in brush. The TWRA has placed around 40 fish attractors throughout Center Hill Lake to ensure good fishing.

Tailwater Fishery. Once Center Hill Dam was constructed the seasonal flows, water temperature, and water quality changed radically. Upper tailwater temperatures near the dam remain between 6 and 10 degrees Centigrade (42 to 50 degrees Fahrenheit) for much of the year. This would approach the winter average of a free flowing stream. Cold discharges and highly variable flows from the dam created an environment that can be tolerated by only a few native species of fish and aquatic invertebrates. Presently, the fish communities in the Caney Fork River below the dam is composed of remnants of the pre-impoundment populations, but include artificially propagated, stocked rainbow and brown trout, and species reaching the tailwater by way of entrainment from the lakes during operation of the turbines and spillways. Blacknosed crappie (*Pomoxis nigromaculatus*), were stocked in the Center Hill reservoir, and now occur in the tailwater. Seasonally, however, walleye, sauger, and white bass enter the tailwaters and congregate near the dam in the winter and early spring. Entrained gizzard shad (*Dorosoma cepedianum*) and threadfin shad (*Dorosoma petenense*) provide the bulk of the forage for predatory species. Striped bass (*Morone saxatilis*) and white bass-striped bass hybrids, originating from fingerlings stocked in the Cumberland River, are increasingly taken in the lower reaches of the tailwater. Several rough fish species are common, including common carp (*Cyprinus carpio*), buffalo (*Ictiobus spp.*), river herring (*Clupeidae spp.*), and drum (*Aplodinotus grunniens*), while channel (*Ictalurus punctatus*) and flathead (*Pylodictus olivais*) catfish are also caught.

Beginning in the 1950s, the tailwaters were periodically stocked with rainbow trout (*Oncorhyncus mykiss*) produced at federal hatcheries. With the completion of Dale Hollow National Fish Hatchery by the Department of the Interior, Fish and Wildlife Service, additional rainbow and subsequently, brown trout (*Salmo trutta*), were stocked each year. These fisheries have grown steadily in popularity and complement the recreational fisheries of Center Hill Lake.

In the past, instream flow incremental methodology (IFIM) analyses were applied to the Caney Fork tailwater. In the mid-nineteen eighties, for example, a preliminary Physical Habitat Simulation System (PHABSIM) was used to analyze the physical habitat for trout in the tailwater. This work was accomplished cooperatively between the Nashville District, the Waterways Experiment Station, and the USFWS. The PHABSIM analyzed the availability of habitat of suitable depth, velocity, and substrate (particle dominance and cover value) for rainbow and brown trout. The results of this study indicate that the optimal minimum flow requirement for trout below Center Hill Dam is approximately 200 cfs. Consistent water quality and flow improvements would greatly improve the fishery and management options below Center Hill Dam (TWRA, 2006).

<u>Freshwater mussels</u> The streams in the Caney Fork watershed were known for their extensive freshwater mussel beds that were exploited by local residents seeking freshwater pearls (Parmalee and Bogan, 1998). Walker (1964) provides a local report on the fate of many historical mussel beds. In 1880, a large pearl was found at the confluence of Indian Creek and the Caney Fork River. The find resulted in massive pearl hunting where millions of mussels were split open in search of pearls. Caney Fork mussels were gravely depleted. Pearling continued for nearly 35 years. Great Falls and Center Hill Dams changed the river habitat into slow moving, large, deep pools that eliminated the fast, shallow current, riffles and gravel bars required for mussel survival.

Historically, 60 mussel species were found in the Caney Fork River watershed (Layzer et.al., 1993). Ten mussel species, including the endangered Cumberland pigtoe (*Pleurobema gibberum*) were reported upstream of Great Falls Dam. Fifty-one species were reported downstream, in the rest of Caney Fork River watershed (Layzer et. al., 2003). At least 37 (62%) of the 60 pre-impoundment species in the entire Caney Fork River watershed, have been extirpated, including 2 which are now extinct, and seven that are federally listed as endangered. (Layzer, 1993). Currently, two species have been found in Center Hill Lake. Downstream of Center Hill Dam, 6 species were found alive among relic shells of 31 additional species. No living mussels were found for 12 km (7.5 miles) in the tailwater below Center Hill Dam. Species found alive further downstream in the tailwater, were few and old. The existing condition in the tailwater shows that species that could not adapt to the fluctuating daily flows, cold hypolimnetic water discharges, alternating bed scouring and dewatering, low DO, and loss of nutrients, did not survive.

Table 5. Live Mussels in Center Hill Lake and Tailwater, 1993.

Common Name	**Scientific Name**	**Location**
Mucket	*Actinonaias ligamentina*	Tailwater
Threeridge	*Amblema plicata*	Tailwater
Spectaclecase*	*Cumberlandia monodonta*	Tailwater
Elephantear	*Elliptio cassidens*	Tailwater
Washboard	*Megalonaias nervosa*	Tailwater
Pink Heelsplitter	*Proptera (Potamilus) alata*	Center Hill Lake
Pimpleback	*Quadrula pustulosa*	Tailwater
Lilliput**	*Toxolasma parvus*	Center Hill Lake

* Federally listed as a Candidate Species
** State listed as under Special Concern in Tennessee (Parmalee and Bogan, 1998).

<u>Aquatic Insects</u>. Cold discharges and highly variable flows from Center Hill Dam have created an environment that can be tolerated by only a few species of aquatic invertebrates. Invertebrate populations of the tailwaters increase in diversity in direct proportion to distance from the dams (TN Dept Health 1967, TWRA, 2006). The species found nearest the dam are akin to communities occurring in natural springs. Isopods of the genus *Lirceus*, amphipods

(*Gammaridae*), and midges (*Chironomidae*) are the most frequently encountered groups. Mayflies (*Ephemeroptera spp.*), stone flies (*Plecoptera spp.*), and caddis flies (*Trichoptera spp.*), crayfish (*Decapoda spp.*), and small populations of freshwater mussels (*Unionidae spp.*) are present in the down stream reaches.

3.7 Minimum Flow for Trout Fishery. The Caney Fork River tailwater, from river mile 25.4 to the mouth, is classified as a trout stream (TDEC, 2004b). Under this designated use, State water quality criteria (TDEC, 2004a and 2004b) stipulates a DO of not less than 6 mg/l, and a temperature limit of no greater than 20° C (68° F). In June 1992, an Environmental Assessment (EA) of the effects of grouting the right and left embankments of Center Hill Dam was prepared and a mitigated Finding of No Significant Impact (FONSI) was signed on June 19, 1992. The FONSI concluded that if the grouting was successful the minimum flow that sustained the trout fishery below the dam would be significantly diminished. The FONSI committed the Corps to mitigate successful grouting at Center Hill Dam by a combination of turbine pulsing and operation of the station service generator. Since that time two additional studies were done at Center Hill Dam to look into alternate methods to improve DO in the tailwater and provide minimum flows for trout. These alternatives included a re-regulation weir and a Howell Bunger valve. Both methods were deemed either inefficient or ineffective. To date the Corps has been unsuccessful at restricting the seepage at the dam that currently provides DO and flow during times of no generation.

From August to October of each year, oxygen is depleted in the water released during power generation that stresses the trout fishery below Center Hill Dam. In 2004, the Corps experimented with various structural options to address the lack of minimum flow for trout and seasonally stressed DO conditions in the tailwater. The Corps modified the turbines in the hydropower plant by installing hub baffles and supplemental air supply lines to inject air into the turbines to raise the DO level in the tailwater. These changes improved the DO levels but failed to solve the problem (Corps, 2004). In the fall of 2005, the Corps implemented an innovative scheme of blending hydropower generation discharges with sluice gate releases. The sluice gate is a 4ft X 6ft opening through the dam located at EL 496 and provides about 1,200 cfs. Water from the sluice gate draws from the lower portion of the hypolimnion and flows directly through the dam and not through the generators. The water rushes through the sluice gate producing a turbulent flow, but greatly improved DO in the tailwater, enough to keep the trout fishery intact into the cold months. As a result, the Caney Fork River has the potential to support trout survival over several years (Corps, 2006).

In 2005 and 2006, two EAs were completed to address impacts of repairs at Center Hill Dam. As with the 1992 grouting FONSI, both EAs concluded that if repairs were successful, the seepage flow that sustains the trout fishery below the dam would be significantly diminished. The Corps committed to mitigate successful grouting at Center Hill Dam by ensuring a continuous flow for trout, in addition to the minimum flow needed for Old Hickory Dam discharges. Seepage currently supplies a steady flow of about 127 cfs of cold oxygenated water when there is no discharge from Center Hill Dam. To replace the seepage flow, the Corps is installing an orifice gate over a sluice gate to provide a minimum of 200 cfs of cold oxygenated water below the dam. The orifice gate is planned for operation in the fall of 2007.

3.8 Wetlands. The dam site and switchyards are highly developed, completely artificial areas. The sites were examined for jurisdictional waters of the U.S., including wetlands, through a combination of in-house research and field investigations. In-house research included a review of published information sources such as U.S. Geologic Survey 7.5-minute quadrangle topographic maps and U.S. Department of Agriculture Soil Conservation Service soil survey maps. A search of the National Wetland Inventory indicated that many pockets of freshwater emergent and forested/shrub wetlands are scattered adjacent the tailwater of the Caney Fork River. Very few wetlands of any type exist along the shoreline of Center Hill Lake. It is likely that the variable lake elevations, rocky shoreline and bluffs do not support wetlands. One large expanse of freshwater emergent and forested/shrub wetlands are indicated in the tailwater of Great Falls Reservoir (USFWS, 1979). Dam construction may have deprived wetlands and shorelines of enriching sediments, changed the ability of natural systems to both absorb hydraulic energy and filter pollutants from surface waters, and caused interruptions in the different life stages of aquatic organisms (EPA: Guidance 1993). As these changes would have occurred more than fifty years ago, none of this was documented.

3.9. Upland Habitat. The Center Hill project can be characterized as having a mixed mesophytic deciduous forest vegetation type. Forest community classifications for the Center Hill area include upland hardwoods, red cedar stands, cove hardwoods and wetlands. Surrounding areas are labeled as an oak-hickory complex interspersed with Eastern red cedar. Trees common to the area include oaks (*Quercus spp.*), hickories (*Carya spp.*), yellow poplar (*Liriodendron tulipifera*), black walnut (*Juglans nigra*), white ash (*Fraxinus Americana*), hackberry (*Celtis occidentalis*), elms (*Ulmus spp.*), American beech (*Fagus grandifolia*), and blackgum (*Nyssa sylvatica*). Common understory species associated with this type include flowering dogwood (*Cornus florida*), black cherry (*Prunus serotina*), redbud (*Cercis Canadensis*), and persimmon (*Diospyros virginiana*). The State-listed species known to occur within a 1-mile radius of the project area are Price’s potato bean (*Apios priceana*), Svenson’s wild-rye (*Elymus svensonii*), Harper’s umbrella-plant (*Eriogonium longifolium var. harperi*), Western wallflower (*Erysimum capitatum*), fen orchis (*Liparis loeselii*), and nodding rattlesnake-root (*Prenanthes crepidinea*).

Forests in the area have been repeatedly cut. Prior to acquisition by the federal government, the lands now surrounding the lake were often burned to remove unwanted stubble and to regenerate growth of wild grasses. As a result of this burning, fire scars may still be seen on older trees. Because of the change in land practices brought about by federal management, good stands, particularly of yellow poplar (*Liriodendron tulipifera*), now occupy the heads of coves and abandoned fields.

Center Hill Lake receives a high degree of recreational use. Conversely, where the terrain is steep around the lake, most of the public lands receive very little use. Undeveloped public lands predominantly consist of maturing mixed hardwood forests, which are separated from open fields on adjacent private property by borders of fencerows lined with secondary growth. A small percentage of the lands are leased to adjacent landowners for hay and/or grazing purposes and provide a small amount of open field habitat. Wildlife habitat on the dam is almost non-existent and is, in fact, discouraged. The earth embankment is planted in grass and mowed so it can be monitored for structural integrity.

3.10. Wildlife Resources. More than 15,000 acres of public land and 4,500 acres of TWRA-operated Wildlife Management Area are available for wildlife habitat. Lands surrounding Center Hill Reservoir are managed to promote beneficial habitat conditions for both game and non-game species of wildlife. Present conditions are most favorable to species such as white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), squirrel (*Sciurus spp.*) and other animals associated with mature forest habitat. The state listed Cerulean warbler (*Dendroica cerulea*) is known to occur within a 1-mile radius of the project area.

3.11. Threatened and Endangered Species. Several species known to reside in the region around Center Hill Dam or in the tailwater are listed as either threatened or endangered by state or federal agencies. Several bird species such as the peregrine falcon (*Falco peregrinus*) and the bald eagle (*Haliaeetus leucocephalus*) which have recovered and been delisted may transit or migrate through the area. The golden eagle (*Aquila chrysaetos*), and the gray bat (*Myotis grisescens*) may also occasionally visit the area. A few mussels may still survive in the tailwaters. Many of the records are based on old, weathered shells. Based on information provided by the US Fish and Wildlife Service, these mussels do not reproduce in the temperatures that currently exist below the dams. If any still survive it is unlikely that they are reproducing. A list of endangered species with records within the immediate project area and the broader study area are found in Table 5.

Table 6. Federally listed species in Center Hill Project and study areas.

Scientific Name	Common Name	Status
Alosa alabamae	Alabama Shad	C
Apios priceana	Price's Potato-bean	LT
Arabis perstellata	Braun's Rockcress	LE
Astragalus bibullatus	Pyne's Ground-plum	LE
Charadrius melodus	Piping Plover	LE
Conradina verticillata	Cumberland Rosemary	LT
Cumberlandia monodonta	Spectaclecase	C
Cyprogenia stegaria	Fanshell	LE
Dalea foliosa	Leafy Prairie-clover	LE
Dromus dromas	Dromedary Pearlymussel	LE
Echinacea tennesseensis	Tennessee Coneflower	LE
Epioblasma brevidens	Cumberlandian Combshell	LE
Epioblasma capsaeformis	Oyster Mussel	LE
Epioblasma florentina florentina	Yellow-blossom pearly mussel	LE
Epioblasma florentina walkeri	Tan Riffleshell	LE
Epioblasma obliquata obliquata	Catspaw or Purple Cat's Paw	LE
Epioblasma torulosa torulosa	Tuberculed-blossom pearly mussel	LE
Etheostoma boschungi	Slackwater Darter	LT
Etheostoma sp. D	Bluemask (=Jewel) Darter	LE
Falco peregrinus	Peregrine Falcon	LE
Hemistena lata	Cracking Pearlymussel	LE
Lampsilis abrupta	Pink Mucket	LE
Lesquerella globosa	Short's Bladderpod	C
Lesquerella perforata	Spring Creek Bladderpod	LE
Lexingtonia dolabelloides	Slabside Pearlymussel	C
Myotis grisescens	Gray Bat	LE

C – Candidate for Federal List
LE – Federally listed as endangered.
LT – Federally listed as threatened.

3.12. Historic Properties - Archaeological, Historical, and Cultural Resources. Section 106 of the National Historic Preservation Act requires Federal agencies to take into account the effect of their undertakings on historic properties. Historic Property means any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register of Historic Places. The term includes artifacts, records, and remains that are related to and located within such properties. The term also includes properties of traditional religious and cultural importance to Indian tribes that meet the National Register criteria of significance. Regulations at 36 CFR 800 define a process for taking such effects into account.

Studies undertaken by the U.S. Army Corps of Engineers, Nashville District, have concluded that the Center Hill Dam and original facilities associated with the dam are considered eligible for listing in the National Register of Historic Places. These studies included an inventory of the historic features, objects, and fabric of the Center Hill Dam and Powerhouse.

An archeological survey of the Center Hill reservoir pool area was conducted in 1947 immediately prior to the filling of the reservoir under the auspices of the Smithsonian Institution's River Basin Surveys program. Thirty-nine archeological sites or locations were recorded in the survey, including three large "temple" mounds, three small earth-rock mounds, and two other sites which may be artificial mounds. In addition, the survey recorded three caves with indications of possible prehistoric occupation, and twenty-eight open village sites. The survey report recommended fairly extensive excavations to salvage important archeological data and materials that would otherwise be irretrievably lost with the closing of the dam and inundation of the pool area; however, no funding was provided to implement the excavations. Unfortunately, the results of the 1947 survey were not provided to the State of Tennessee and the sites that were recorded do not appear in the state's archeological site files. On-going and proposed archival research at the Smithsonian and other institutional locations will attempt to rectify this situation and complete the site file record for the Center Hill reservoir area.

Several subsequent archeological surveys have been conducted within floodplain areas along the Caney Fork below Center Hill Dam, primarily as a consequence of highway and bridge construction. These surveys have recorded numerous significant archeological sites representing the full timeline of human occupation in the region.

3.13. Environmental Justice. Executive Order 12898 requires that extensive outreach and opportunity for involvement will address concerns of all communities and that minority residents and low-income residents receive fair and equitable consideration for any potential adverse health and environmental effects from proposed actions. Demographic information of the surrounding area, based on US Census information and other web searches, indicates no differential demographics based on ethnic or cultural factors. The percentage of minority communities in the surrounding area in DeKalb County (7.6%) is far below the state (22.1%) and national average (33.1%). The poverty level of DeKalb County (16.4%) is above the state (15.0%) and national average (12.7%).

3.14. Hydroelectric Resources. Hydropower was one of the two originally authorized project purposes. Tailwater releases are used to generate hydropower and it helps maintain electricity generated by thermal power production on the Cumberland River (Corps, 1998 Manual). The electrical energy produced by the project is sufficient to supply the needs of an average city with a population of 375,000. Between 1983 and 2004, hydropower returned an average of $3.8 million in hydropower revenues to the Treasury annually. Maximum hydropower benefits depend on the lake elevation being kept around Elevation 648. The daily generation schedule typically follows the peak demand for power, which occurs in morning and evening in winter, and afternoons in summer. Center Hill has three 45-MW turbines, for a total hydropower plant capacity of 135-MW. Peak flow capacity through the turbines is approximately 11,000 cfs.

In general, hydropower releases are scheduled to meet peak energy demands. Normally this results in more water being discharged during the Monday through Friday period with lesser amounts on the weekend. Strict adherence to peak power demand scheduling would result in adverse affects to the aquatic life in the tailwater, particularly during the low flow, low dissolved oxygen, high temperature months of the late summer and early fall. The minimum requirement effective from June 1 through November 30 is the discharge resulting from one unit generation for one hour within any 48-hour period. Every effort is made to provide some discharge in excess of the minimum requirement every day of the week for the benefit of the ecosystem of the Caney Fork below the dam (Corps, 1998).

3.15. Flood Control. Flood control is one of the originally authorized project purposes for Center Hill Dam. There are two distinct modes of operation relative to flood regulation: 1) Normal flood operation where outflows are reduced to provide flood protection to Carthage, Tennessee and other points downstream including the primary damage center of Nashville, Tennessee; and, 2) Emergency flood operation where downstream flood reduction is an objective, but protection of the dam structure is the prime concern (Corps, 1998).

The general result of such regulation is a seasonal variation in the reservoir surface elevations. Under normal operating conditions, the routine pattern is to lower the reservoir close to the bottom of the power pool (EL 623.5) by November. Winter and spring runoff events result in peak reservoir surface elevations between April and June. Floods are held in the reservoirs until the Cumberland River water levels recede to non-damaging levels at which time the flood storage volume is discharged. Then, beginning in June, the reservoir level is gradually lowered throughout the summer and fall in preparation for flood storage to capture winter and spring storm events. Releases are usually made through the turbines for power production. This routine operation has significantly reduced flood stages at Nashville, Tennessee, the major damage center on the river, and has contributed to flood damage reduction as far downstream as the lower Mississippi River. Since its completion, Center Hill Dam has prevented $35.5 million per year in flood damage.

The flood damage area from a catastrophic dam failure would encompass the floodplain of nearly 30 miles the Caney Fork and over 250 miles of the Cumberland River to Barkley reservoir. The communities immediately downstream of the dam (Lancaster, Gordonsville and Carthage) are primarily agricultural and residential. Five interstate highway bridges (I-40) could be overtopped with damage. The Cumberland River floodplain would be damaged and downstream cities of Hartsville, Gallatin and Hendersonville would suffer residential, commercial, agricultural and extensive infrastructure damage. The Tennessee Valley Authority's (TVA) Gallatin Steam Plant could experience property damage. The largest damage center is the metropolitan Nashville and Davidson County. Over 9,000 structures in the 100-year floodplain could incur damage estimated at approximately $1.3 billion. Large industrial areas along the river would be especially impacted. Downstream of Nashville, Ashland City and Clarksville would incur extensive damages. Three Corps of Engineers dams on the Cumberland River may be overtopped – Cordell Hull, Old Hickory and Cheatham (Corps, 2006 rehab report).

3.16. Water Supply. Although water supply was not originally an authorized project purpose at any Nashville District project, all but one project is used by municipalities for this purpose. Out of 10 projects, Center Hill ranks fifth in terms of the population served. In 1990 it was estimated that this project serves as the water supply source for about 45,000 people through two water systems which directly access the lake and through seven additional systems which purchase water from those systems. The two direct access systems withdraw approximately 11 cfs from Center Hill Lake. A significant portion of this amount is returned to the Cumberland Basin via sewage treatment plant discharges (Corps, 1998).

3.17. Air Quality. Ambient air quality is described by comparing current pollutant concentrations to the National Ambient Air Quality Standards (NAAQS) established by the Clean Air Act. NAAQS are threshold concentrations of criteria pollutants set to protect human health and welfare. There are six criteria air pollutants: lead, carbon monoxide, sulfur dioxide, nitrogen oxides, ozone and fine particulate matter (PM2.5). When measured concentrations of these pollutants exceed the NAAQS, the area is usually designated as a "non-attainment" area by the EPA. The air quality in the Center Hill Dam area is generally good and is in attainment for all NAAQS criteria (USEPA website, 2007).

3.18. Noise. The Center Hill project is located in a rural setting. Most of the noise associated with operating a hydropower plant is contained within the structure. The remainder is localized and incidental except for warning horns that sound prior to beginning generation. The main source of continuous noise is Highway 96 which runs across the top of the dam.

3.19. Recreation. Recreation was not originally an authorized project purpose. The Federal Water Project Recreation Act of 1965 established development of the recreational potential at federal water resource projects as a full project purpose. Because of the temperate climate and relatively long recreation season, visitors have many opportunities to fish, hunt, camp, picnic, boat, canoe, hike, and enjoy the outdoors. Recreational fishing and boating, particularly trout fishing and canoeing, are by far the major activities accounting for visitation. A total of 35 useable boat ramps are available for lake access (Table 6). Corps facilities at the dam include camping facilities, boat ramps, comfort stations, RV hookups, picnic pavilions, and playground facilities. Many users camp in conjunction with fishing for trout. There are 4 boat ramps and 5 access points to the Caney Fork River tailwater below the dam. Center Hill Lake includes nine developed Corps recreation areas with 3 swimming beaches, 8 playgrounds, 3 campgrounds (230 total campsites), 9 commercial marinas (2,453 boat slips, 690 houseboats), 2 state parks, Burgess Falls State Natural Area, and five restaurants. The number of boat slips/houseboats on Center Hill ranks third behind Lake Cumberland and Dale Hollow. Center Hill Lake is the fourth most visited lake in the Corps Nashville District.

Table 7. Center Hill Lake Boat Ramp Elevations (EL)

Boat Ramp Location	EL	Boat Ramp Location	EL
Center Hill Recreation Area	622.0	Horseshoe Bend Marina – formerly Webb's Camp	628.93
Center Point	625.93	Hurricane Bridge Recreation Area Old – East	620.85
Cookeville Dock (Badly broken below 625)	622.0	Hurricane Bridge Recreation Area New - West	626.16
Cove Hollow #1 – ramp closest to store	627.0	Hurricane Dock	618.0
Cove Hollow #2	622.0	Indian Creek	624.0
Cove Hollow Recreation Area (Closed Area)	622.0	Indian Creek Youth Camp	633.0
Dubland Access – Mountain Harbor-Riverwatch	626.5	Johnson Chapel	622.5
Edgar Evins State Park Ramp #1	630.0	Lakeside Resort	634.3
Edgar Evins State Park Ramp #2	622.6	Lakeview Mountain Estates	624.0
Falling Water Retreat	635.0	Pates Ford Marina	618.0
Floating Mill Campground (Extended 1-07)	620.3	Puckett's Point	627.36
Floating Mill Day Use (Fully extended 1-07)	624.0	Ragland Bottom Campground (Fully extended 1-07)	629.1
Four Seasons Marina	626.57	Ragland Bottom Day Use (Extended 1-07)	618.0
Hickey Access	630.9	Rock Island State Park	629.07
Hidden Harbor Dock (Unusable below 625)	620.0	Sligo Dock (Unusable below 625)	622.0
Holiday Haven Access	630.31	Still Point	628.37
Holmes Creek Campground*	627.9	South Shore	626.5
Holmes Creek Day Use*	623.4	Warren County Park (Closed Area)	626.62
Holmes Creek Old Dock Site	636.0		

* New Hidden Harbor Marina Sites

The number of visitations at the project was provided by the Operations staff for the ten year period starting in 1996 and ending in 2005. The annual numbers were summed and averaged to get a normalized visitation count, which equaled 3.6 million per year. The recreation benefits were computed by multiplying the number of visitations by the unit day value of $7.94 per visitor. The results were an average of $29.0 million in recreation benefits per year for the Center Hill project (Seepage Report, 2007). During February 2007, four boat ramps were extended to provide improved access to the lake.

3.20. Aesthetics. Center Hill Dam is in a rural location surrounded by rolling, wooded hills. The dam is comprised of a gray concrete structure and a mowed grass earthen embankment, and topped by a highway. The tailwater shoreline and Center Hill Lake shoreline are virtually all wooded with scattered areas of farm fields. In Center Hill Lake, the customary summer pool (EL 648.0) extends to the tree line. The customary winter pool drops approximately 24.5 feet (EL 623.5) exposing a rugged lake shore of cobble and bluffs. Protecting the shoreline from overuse and the preservation of the natural beauty of the public lands and water for all citizens is a major goal of the Center Hill Lake Shoreline Management Plan that is implemented by the Corps Resource Manager and staff. The Corps recreation program mission is to provide quality outdoor public recreation experiences to serve the needs of present and future generations. The Corps recreation program goal is to enhance the quality of American life by providing benefits to individuals, communities, the national economy, and the environment. Pedestrian access, boating, fishing, hunting, hiking, camping, birding, and photography are allowed in the project area as long as they are compatible with the aesthetic protection of the shoreline, the Center Hill project and with state hunting, fishing, and boating laws.

3.21. Economics. Center Hill dam is a significant economic factor in the region. In addition to the recreation, hydropower, and flood control, the dam provides many other advantages including ancillary navigation benefits, municipal water supply, increased property values, increased tax revenues, and employment opportunities.

Center Hill Dam has prevented significant flood related damages over the years. It is estimated that more than $285 million of damages have been prevented. The level of safety provided by the dams has encouraged the development of communities and businesses along the Caney Fork and Cumberland Rivers.

The relatively inexpensive and dependable electricity provided by the power plants has contributed to the region's economic well-being. Center Hill annually generates an average of 415,919 MW at an estimated value of more than $3.2 million.

Recreation has become a major factor in the regional economy. Center Hill claims an average of more than $92 million in recreation benefits. In 2002, visitors spent over $110 million within 30 miles of Center Hill.

Since Center Hill Dam altered the temperatures of the tailwaters from cool to a cold-water stream, the wildlife agencies have developed trout fisheries in the tailwater. These fisheries provide many hours of recreational benefits and have a strong effect on the local economy. Recent surveys of trout fishermen below Center Hill indicate that more than 21,000 visits are made annually and that they contributed $675,233 to the economy. TWRA's goal is to increase that to 25,000. On several instances, newly released trout have been killed by hydropower releases containing low DO levels. In addition, low flows impact the fisheries by limiting available habitat and food sources.

Economic impacts refer to employment, employment income, industrial output and federal and state tax revenue that occur as the result of consumer expenditures on hatchery-related goods and services. TWRA estimates that the trout fishery below Center Hill had a total economic impact of $1.8 million dollars (TWRA 2003). Studies indicate that in a diminished condition, sport fishing on the Caney Fork River tailwater generated in excess of one million dollars annually for the local economy. According to TWRA, the existing fishery is only about 50 percent of what the Caney Fork is capable of supporting with restored water quality.

3.22. Navigation. Center Hill Dam has no lock, and navigation is not an authorized project purpose. However, the regulated stream flow and water releases for project purposes provide ancillary benefits to navigation by contributing to the flows needed to maintain a commercially navigable channel on the lower Cumberland, Ohio, and Mississippi Rivers.

The Cumberland River provides a 9-foot, commercially navigable waterway from the mouth to Celina, Tennessee, a distance of approximately 381 river miles. There are 36 commercial river terminals downstream of Cordell Hull Dam. There are 154 small boat harbors, ramps, and landings below Cordell Hull Dam.

In 2005, over 23 million tons of commodities, valued near 2.1 billion dollars, were transported on the Cumberland River. Typical commodities shipped on the Cumberland River include coal, limestone, asphalt, grains, aggregates, zinc ores and concentrates, iron and steel, petroleum products, bulk cement, and chemicals.

3.23. Hazardous, Toxic, or Radiological Wastes. At a minimum the dam is inspected annually for any HTRW or other environmental concerns through the Corps' Environmental Guide Review for Operations (ERGO) and OSHA programs. Currently there are no known Hazardous, Toxic, or Radiological Waste (HTRW) concerns in the project study area.

3.24. Traffic. US Highway 96 traverses the top of the dam and serves as a major connection between the two sides of the Caney Fork River.

3.25. Safety. Safety is an intrinsic consideration in the planning and operation of Center Hill Dam. One of the authorization purposes for constructing Center Hill Dam was to reduce the loss of lives and property from flooding. Maintaining the structural integrity of the dam is, therefore, a priority.

3.26. Floodplain Management. Executive Order 11988, Floodplain Management, requires federal agencies to evaluate and minimize impact on floodplains. Center Hill Dam repairs and Center Hill Lake pool operations would inherently occur within the Caney Fork River floodplain.

4.0 Environmental Consequences

The proposed project area for interim pool elevation alternatives is located at Center Hill Dam and Lake. However, the impacts of altering pool elevations below the PMB have consequences that reach far beyond the immediate lake. Many impacts would be felt throughout the Cumberland River Valley. This section describes important resources that could be affected by the various alternatives including the No Action, Existing, and Preferred Alternatives. Alternatives 1 – 7 denote interim pool elevations showing the top and bottom pool elevations respectively. Alternatives 8 is a pool with a goal to maintain the one pool elevation listed all year long. Alternative 9 represents an emergency drawdown.

4.1. Environmental Setting and Physiography. No alternative would affect physiographic location.

4.2. Hydrology and the Cumberland River Reservoir System. The regulated hydrology of the Cumberland River Basin has resulted in an interdependence on the 10 Corps projects to meet project purposed not only at each individual project, but to contribute or regulate the mainstem of the Cumberland River. However, when a major storage dam is not able to contribute or hold back stored water, other projects must make up the shortfall during drought, or store water during a flood. Localized effects could be significant at the impaired project site. Wolf Creek Dam is also undergoing repairs and its pool level has been drawn down. Wolf Creek normally contributes up to 69% of the Cumberland River flow. A lack of customary flows from Wolf Creek and a drawdown at Center Hill, would put pressure is on Dale Hollow to make up adequate flow contributions. It is very likely that Dale Hollow would be unable to meet these demands, even if it was drained. How much water Center Hill would be able to store and release to the system under drought conditions is dependant on the interim elevation alternative selected and weather:

- **Alternative 1**, (EL 648.0/623.5) No Action – Under this alternative, the pool elevation would be managed to operate at or above the top of the summer PMB curve, which would dramatically raise the risk of dam failure. This alternative would be able to supply all 16% of the water needs to the system.
- **Alternative 2**, (EL 645.0/623.5) – This alternative is within the summer PMB curve. This alternative would be able to supply slightly less than 16% of the water needs to the system.
- **Alternative 3**, Existing Condition, (EL 640.0/623.5) - This alternative is at the bottom of the summer PMB curve. This alternative would be able to supply around half of the usual supply (16%) of the water needs to the system.
- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) – This proposed summer pool elevation (EL 635.0) would operate the pool just under the bottom of the summer PMB curve. This alternative may be able to supply some of the water needs critical to the system.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.0) - This alternative would set the lake elevation 10 feet below the summer PMB curve. This alternative would barely be able to supply any water including critical needs to the system.

- **Alternative 6**, (EL 625.0/623.5) – Under this alternative, pool elevation would be managed to operate 15 feet below the summer PMB curve. This alternative would not likely be able to supply any of the water needs to the system.
- **Alternative 7**, (625.0/618.0) - Under this alternative, pool elevation would be managed to operate 15 feet below the summer PMB curve. This alternative would not likely be able to supply any of the water needs to the system.
- **Alternative 8**, Flat-line, (EL 622.0) – This alternative is 18 feet below the summer PMB curve. This alternative would not supply water to the system except during sporadic releases to maintain the flat-line during high inflow events. Minor flooding could occur downstream in order to maintain the flat-line.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – This alternative is 78 ft below the congressionally authorized minimum pool elevation of EL 618.0; and 108 ft below normal summer pool (EL 648.0). This alternative would eliminate any supply of water to the system except during sporadic releases to maintain the emergency drawdown during high inflow events. Minor flooding could occur downstream in order to maintain the emergency drawdown.

4.3. Water Quantity. Water quantity contribution from Center Hill (16%) is described in Section 4.2 Cumberland River Reservoir System. Water quantity is an important consideration during typical and drought years as described here. It is understood that lowering pool elevations would increasingly benefit flood storage, however, the availability of water quantity downstream and upstream Center Hill dam to meet other project purposes are described below:

- **Alternative 1**, (EL 648.0/623.5) No Action – Under this alternative, the pool elevation (normal summer pool) provides 100% of the water quantity needed to support all project uses, the Cumberland River system, and drought conditions. However, during dam repairs, a dam failure or minimally, loss of the pool would eliminate all water storage.
- **Alternative 2**, (EL 645.0/623.5) – This alternative would supply about 85% of the quantity of water needed for all project uses, the system, and drought conditions.
- **Alternative 3**, Existing Condition, (EL 640.0/623.5) - This alternative would supply approximately 71% of water quantity needed for all project uses, the system, and drought conditions.
- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) –This alternative would supply approximately 54 % of water quantity minimally needed for all project uses, the system, and drought conditions.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.0) - This alternative would supply approximately 37% of water quantity needed for all project uses, the system, and drought conditions. Under extended drought conditions, this volume could be depleted resulting in no water to the system and loss of some project uses.
- **Alternative 6**, (EL 625.0/623.5) –This alternative would supply approximately 21% of water quantity needed for all project uses, the system. Under extended drought conditions, this volume is expected to be quickly depleted resulting in no water to the system and loss of most project uses of hydropower, recreation, fish and wildlife, and water quality downstream of Center Hill Dam.

- **Alternative 7**, (625.0/618.0) - This alternative would supply approximately 21% of water quantity needed for all project uses, the system. Under extended drought conditions, this volume is expected to be quickly depleted resulting in no water to the system and loss of most project uses of Hydropower, Recreation, Fish and Wildlife, and Water Quality downstream of Center Hill Dam. This alternative would provide a wider operating band, and thus greater flexibility in operating the system than Alternative 6.
- **Alternative 8**, Flat-line, (EL 622.0) – This alternative would supply approximately 12% of water quantity needed for all project uses, the system and drought conditions. This volume of water would barely supply any water critically needed for drought conditions and loss of project uses of Hydropower, Recreation, Fish and Wildlife, irrigation, and Water Quality downstream of Center Hill Dam.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – Under this alternative, there is no water to supply project uses, the system, or drought conditions up or downstream of Center Hill Dam.

4.4. Water Quality. The various alternatives affect water quality, which includes stratification, DO and temperature, and nutrient concentration in Center Hill Lake, which affects these parameters in the tailwater.

- **Alternative 1**, (EL 648.0/623.5) – Until 2005 this was the customary operating range. Under this alternative, the pool elevation (normal summer pool) provides 100% of the water quantity needed to support water quality status quo both up and downstream Center Hill Dam. However, during dam repairs, a dam failure or loss of the pool would alter water quality. Eliminating the Center Hill pool would eliminate cold water storage. The Caney Fork River would revert back to a warmer water river both up and downstream of the dam. Warm water does not hold as much DO as cold water. Under this scenario it is likely that the Caney Fork River could no longer support its classification as a trout stream.
- **Alternative 2**, (EL 645.0/623.5) –This alternative is virtually the same as the No Action alternative. The primary differences are that there would be slightly less stress on the dam foundation and there would be less cold water storage. Impacts to hydropower would be small. Fish and wildlife, and water supply would be unaffected. Water quality could be lightly impacted as there would be less cold water reserves for use during peak demands during the summer. The existing water quality in the tailwater releases would likely be maintained.
- **Alternative 3**, Existing Condition, (EL 640.0/623.5) – In December, 2006, when the seriousness of the situation became apparent, the Corps lowered the operating band to reduce stress on the dam's foundation until the problems could be more fully assessed. This action had the potential to create a few negative impacts, however, it was determined that the interest of the public's safety and welfare was of primary importance. Potential impacts were that there could be minor impacts resulting from less cold water storage. Less cold water could result in minor impacts to water quality which, in turn, could impact the downstream trout fishery. If the fisheries are negatively impacted, recreation could also decline slightly. Under drought conditions and a longer retention time, anoxic conditions would likely prevail in the hypolimnion as BOD increased with nutrient concentration from point and nonpoint sources. High

BOD in tailwater releases would be compensated for by sluicing which adds the necessary DO and cold water. Cold water temperatures can be maintained as long as the hypolimnion is maintained.

- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) **–**This alternative would have similar but increasingly severe impacts as Alternative 3. Within this operating band less cold water is stored than in the previous alternatives. During warmer months the cold water could be depleted if no effort is made to conserve the pool such as reducing hydropower generation. Warmer water retains less DO. Maintaining water quality standards of DO and temperature for a trout stream classification in the tailwater could become problematic and the downstream trout fishery could be affected. Releases of warmer water would not likely be detrimental to any surviving mussels in the tailwater. However, the amount of flow released from Center Hill Dam may be reduced to conserve the pool and therefore its contribution is not likely to increase water temperature in the Cumberland River.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.5) – Within this operating band there is less cold water storage. Maintaining low temperatures and high DO in the tailwater would be difficult and the situation could be described as serious. A summer storm event could flush the small hypolimnion of the remaining cold water. As a consequence there may be sporadic die-offs of trout in the tailwater and recreation, particularly among trout fishermen would decline. Under drought conditions, low pool, long lake retention time, and continued point and nonpoint source inputs, poor water quality conditions and algal and bacterial blooms could occur in Center Hill Lake. Water supply treatment costs to remove bad tastes and odors could increase. Potential warm water releases from Center Hill Dam would sustain or increase warm water temperatures in the Cumberland River. Warmer water holds less DO which could stress the Cumberland River fishery. Warmer water would also impact the thermal plants that draw water from the Cumberland River for cooling. For thermal plants, the warmer the withdrawal water, the warmer the release water, the warmer the Cumberland River, the more stressed the fishery. Fish kills could occur in the Cumberland. Thermal plants would have to withdraw less water or shut down to prevent increasing water temperature in the Cumberland River.
- **Alternative 6**, (EL 625.0/623.5) **–** Water quality would be noticeably impacted as water temperatures rose and DO declined in the hypolimnion of the lake. There would be little oxygenated cold water in reserve to support downstream water quality for river fish. The trout stream criteria in the Caney Fork River tailwater may be violated and the cold water fishery could be lost in its entirety. In the lake, poor water quality conditions and algal and bacterial blooms may become problematic and water supply treatment costs to remove bad tastes and odors would increase. Fish kills could occur in the Cumberland River which would reduce recreational and commercial fishing. Thermal plants would have to reduce or eliminate power generation to prevent warming the Cumberland River further.
- **Alternative 7**, (625.0/618.0) - Under this alternative, the impact to water quality become increasingly worse and of longer duration than Alternative 6. At the top elevation, there would be little water in reserve to moderate poor downstream water quality in the Caney Fork tailwater or the Cumberland River. Once the lake hits EL

618, no water would be released except to meet downstream water supply needs, The tailwater trout fishery would be eliminated as well as any associated recreation benefits.

- **Alternative 8**, Flat-line, (EL 622.0) – Water quality would be notably impacted as water temperatures rose and DO declined. There would be little water in reserve for downstream uses such as, thermal power support, fish and wildlife, or recreational and commercial fishing in the Cumberland River. The trout stream criteria may be violated and the cold water fishery could be lost in its entirety. Poor water quality conditions and algal and bacterial blooms may become an issue and water supply treatment costs to remove bad tastes and odors would increase. Under a operation, no water would be released when Center Hill Lake reached EL 622.At this elevation, the effects seen at EL 618, under Alternative 7 would be the same.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – Water quality would be severely impacted because Center Hill Lake would be eliminated. There would be no water for downstream uses such as fish and wild life, recreation, hydropower, or fish and wildlife. The downstream trout and lake fishery would be eliminated. Without additional water from Center Hill, poor water quality conditions and algal and bacterial blooms may become a problem in the Cumberland River. At these elevations, water supply would be eliminated.

4.5. Tailwater Releases. Water releases from Center Hill Dam augment discharge flows below Old Hickory Dam to support a minimum DO of 5 mg/l for the Cumberland River warm water fishery. The effect of each alternative would be similar to water quantity and quality impacts on the quantity and quality of releases are as follows:

- **Alternative 1**, (EL 648.0/623.5) No Action – Under this alternative, the pool elevation (normal summer pool) could provide a majority of the water quantity and quality needed to support Old Hickory Dam water releases even under drought conditions. However, during Center Hill Dam repairs, a dam failure or minimally, loss of the pool would eliminate any releases that would support Old Hickory Dam discharges. A catastrophic Center Hill Dam failure could severely damage Old Hickory Dam by overtopping resulting in injury to the Cumberland River fishery.
- **Alternative 2**, (EL 645.0/623.5) – Under this alternative, the high pool elevation provides a large percent of the water quantity and quality needed to support warm water fisheries in the Cumberland River system, even under drought conditions. Some hydrostatic pressure on the dam would exist.
- **Alternative 3**, Existing Condition, (EL 640.0/623.5) – This alternative reduces water storage, and consequently thereby water releases for part of the year. Shallow tailwater would likely warm. There would be some difficulty supplying cold and well oxygenated water to Old Hickory Dam to support the discharge needed to support the Cumberland River warm water fishery and thermal plants. A large tropical rain event could flush some of the hypolimnetic water resulting in a warmer water discharge.
- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) – This alternative would have similar but worse impacts then Alternative 3. The reduced hypolimnion would be susceptible to flushing with a sudden large tropical inflow, resulting in warm water releases. Warm water holds less oxygen. Reduced stored water quantity would reduce proportionally, water releases, by nearly half. There

would be less water for Old Hickory Dam releases. The Cumberland River warm water fishery and thermal plants would be impaired. A dry year would preserve the hypolimnion so that some cold water would be released.

- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.0) - This alternative would have similar but worse impacts than Alternative 4. The significantly reduced hypolimnion would be likely be flushed with a sudden large tropical inflow, resulting in warm water releases. Under a typical and wet year, the small water releases would likely be warm and poorly oxygenated. Some cold and oxygen sustaining releases would possibly occur in a drought year, but there would be little volume to support Old Hickory Dam needs.
- **Alternative 6**, (EL 625.0/623.5) – This alternative would have similar but worse impacts than Alternative 5. A small volume of warm, oxygen poor water could be released from Center Hill Dam resulting in little improvement in Old Hickory Dam releases with no water temperature support for thermal plants.
- **Alternative 7**, (625.0/618.0) - This alternative would be similar to Alternative 6, but would offer a greater operating band, and thus more flexibility. A small volume of warm, oxygen poor water could be released from Center Hill Dam resulting in little improvement in Old Hickory Dam releases with no water temperature support for thermal plants.
- **Alternative 8**, Flat-line (EL 622.0) – This alternative would have similar but worse impacts than Alternative 6. A sudden tropical storm event would result in sporadic minor flooding as attempts are made to sustain a pool elevation. Surges of warm, turbulent flows may improve oxygen content for the Cumberland River warm water fishery but provide little water temperature relief for thermal plants. Once a Flat-line is met, Center Hill releases would likely stop.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – This alternative would have similar to Alternative 8. A sudden tropical storm event would result in sporadic moderate flooding as attempts are made to sustain a pool elevation. Once a Flat-line is met, Center Hill releases would likely stop, including no minimum flow releases.

4.6. Aquatic Resources. - Aquatic resources in Center Hill Lake would be affected by the various alternatives. The tailwater fish and freshwater mussel communities are addressed under minimum flow. The aquatic insect communities would also be affected, but they are ubiquitous and, resilient, and can adapt to a wider range of conditions over a relatively short period of time. Aquatic insects are the first to colonize newly altered aquatic habitat (Caughlin, 2004; Drury and Kelson, 2000) therefore long-term impacts are restricted to fish and freshwater mussels.

- **Alternative 1**, (EL 648.0/623.5) No Action – Under this alternative, Center Hill Lake would sustain current fish and mussels. However, during Center Hill Dam repairs, a dam failure or minimally, loss of the pool would severely damage these communities.
- **Alternative 2**, (EL 645.0/623.5) – Under this alternative, Center Hill Lake would sustain current fish and mussels. These elevations are within normal and routine range of lake elevations. However, this alternative has some risk of dam failure or loss of pool due to some hydrostatic press placed on the dam.

- **Alternative 3**, Existing Condition, (EL 640.0/623.5) – Under this alternative, Center Hill Lake would sustain current fish and mussels. These elevations are within normal and routine range of lake elevations. Impacts would be minimal.
- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) – Under this alternative, Center Hill Lake would sustain current fish and mussels with some minimal impact. During the spring, the low summer pool elevation (EL 635.0) may reduce available fish spawning habitat. The proposed winter pool is about 1.5 feet below the customary winter pool (EL 623.5). Fish attractors, native brush and logs, and under cut banks could be exposed out of water, reducing fish cover, particularly for young-of-the-year. As long as the water level reduction is slow, mussels could move to deeper water.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.0) – This alternative would have similar impacts as Alternative 4, but more problematic in terms of spawning. Center Hill Lake would likely sustain current fish with moderate impact. Available fish spawning habitat could be highly restricted reducing the number of young-of-the-year. As long as the water level reduction is slow, mussels could move to deeper water. Under the customary winter pool (EL 623.5) available fish cover would not be expected to change.
- **Alternative 6**, (EL 625.0/623.5) – This alternative would have similar impacts as Alternative 5, but more of a problem in terms of spawning and crowding. Available fish spawning habitat could be highly restricted reducing the number of young-of-the-year. The spawning window could be delayed as pool levels slowly climb to the new summer elevation (EL625.0). Some fish species are territorial. Crowding could increase stress. .
- **Alternative 7**, (625.0/618.0) - This alternative would have similar impacts as Alternative 6, but would offer greater flexibility. Available fish spawning habitat could be highly restricted reducing the number of young-of-the-year. The spawning window could be delayed as pool levels slowly climb to the new summer elevation (EL625.0). Some fish species are territorial. Crowding could increase stress.
- **Alternative 8**, Flat-line, (EL 622.0) – This alternative would have similar impacts as Alternative 6, but severe in terms of spawning and crowding. Available fish spawning habitat could be highly restricted reducing the number of young-of-the-year. The spawning window could be eliminated as sporadic pool elevations move up and down to maintain the elevation. Crowding due to a low pool could increase stress. Fish attractors would be deeply submerged during a storm event and quickly exposed when is obtained. Mussels may move to shallower depth only to be exposed when the pool is quickly drawn down to meet the .
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – This alternative would have similar impacts as Alternative 8, but more severe. Spawning and young-of-the-year would likely be eliminated. Over crowding could result in fish kills. Below EL 620, only the 4 sluice gates, with a combined discharge of approximately 4,800 cfs, could be used to lower pool. Many lake fish are likely to be flushed through the sluice gates. Dropping the pool fast and low could expose mussels. It would likely take many years for the fish and mussel lake communities to recover.

<u>4.7. Maintenance of the Trout Fishery</u> Seepage flow currently provides 127 cfs of continuous flow into the tailwater even when there is no hydropower generation. For many years, seepage enhanced trout survivability during the warm months under low flow conditions. This action will fulfill the minimum flow requirement in the tailwater. The trout fishery in the tailwater exists because Center Hill Dam provides a reliable source of cold water typically less than 20° C (68° F) year round. In fact, every effort is made to manage the tailwater to best meet the needs of the trout stocked by TWRA. Even with adequate flow and DO, water temperatures above 25° C (77° F) are lethal to trout. However, freshwater mussels require, water temperatures consistently above 15.5° C (60° F) to reproduce. Aquatic insects are also affected by water temperature which changes the community make-up. However, they are highly adaptable and communities can quickly re-establish to new conditions. As a result, while all alternatives would affect aquatic insects, the impact would be temporary and insignificant.

A continuous cold water discharge is determined not only by the location of the outlet structures that access the hypolimnion, but the size and depth of the hypolimnion, and weather. The location of the turbine penstocks (EL 540) and sluice gates (EL 496) are fixed, but the size and depth of the hypolimnion is dependent on pool elevation. How weather affects the hypolimnion is dependant on the existing size of the pool and the volume of inflow. The impact of the interim pool elevation alternatives on the aquatic resources below the dam are considered below:

- **Alternative 1**, (EL 648.0/623.5) No Action – Under this alternative, the hypolimnion is large and deep and easily accessed by the outlet structures. Because of its size, normal storm inflows during the summer have little effect. The customary summer pool has supplied enough cold water to sustain a trout fishery for nearly 50 years, but to the detriment of the freshwater mussel community. However, during Center Hill Dam repairs, a dam failure or minimally, loss of the pool would severely damage these communities.
- **Alternative 2**, (EL 645.0/623.5) –Under this alternative, the high pool elevation still supports a large deep hypolimnion. This option provides the water quantity and quality needed to support the tailwater trout fishery. Though lowered, some hydrostatic pressure still exits on the dam.
- **Alternative 3**, Existing Condition, (EL 640.0/623.5) – This alternative reduces water storage by nearly a third, which reduces the depth of the hypolimnion. Consequently, the penstocks could draw some of the warmer water above the hypolimnion. Even if DO and flow are adequate, the potential of warmer water releases, even by a few degrees, would stress trout, but not mussels.
- **Alternative 4**, **<u>Environmentally Preferred Alternative,</u>** (EL 635.0/623.5) – Impacts of this alternative are similar to Alternative 3 but weather has a greater influence. Water storage is reduced by nearly half, which reduces the depth of the hypolimnion. Consequently, the penstocks would draw some of the warmer water above the hypolimnion. During a wet year, high warm inflows could partially mix in the hypolimnion. A flood event could mix and warm the hypolimnion. Even with minimum flow and adequate DO, warmer water for a sustained length of time would stress trout and potentially be lethal. However such a condition would be very beneficial to the mussels.

- **Alternative 5**, **<u>Dam Safety and Engineering Preferred Alternative,</u>** (EL 630.0/618.0) - Impacts of this alternative is similar to Alternative 4 but worse, and weather has a greater influence. Water storage is reduced by nearly two-thirds, which reduces the depth of the hypolimnion. Consequently, the penstocks would draw warmer water above the hypolimnion. During a typical and wet year, high warm inflows could partially mix in the hypolimnion. A flood event could mix and warm the hypolimnion. Even with minimum flow and adequate DO, warmer water for a sustained length of time would stress, and potentially be lethal to trout, but such a condition would be very beneficial to the tailwater mussels.
- **Alternative 6**, (EL 625.0/623.5) – Impacts of this alternative is similar to Alternative 5 but worse, and weather would have a greater influence. Water storage is reduced by nearly three-quarters, which reduces the depth of the hypolimnion. It is likely that a significant rainfall event could flush the hypolimnion. Even with adequate flow and DO, water temperatures above 25^{O} C (77^{O} F) are lethal to trout. Under this same condition, tailwater mussels may thrive. Warm water host fish may move into the tail water long enough to allow glochidia transfers.
- **Alternative 7**, (625.0/618.0) - Impacts of this alternative is similar to Alternative 5 but are more problematic, and weather would have a greater influence. It offers greater flexibility that Alternative 6. Water storage is reduced by nearly three-quarters, which reduces the depth of the hypolimnion. It is likely that a significant rainfall event could flush the hypolimnion. Even with adequate flow and DO, water temperatures above 25^{O} C (77^{O} F) are lethal to trout. Under this same condition, tailwater mussels may thrive. Warm water host fish may move into the tail water long enough to allow glochidia transfers.
- **Alternative 8**, Flat-line, (EL 622.0) – Impacts of this alternative are similar to Alternative 6 but worse. Water storage is reduced by nearly 90% which reduces the depth of the hypolimnion. In order to maintain a , pool elevation would be drawn down as quickly as possible. Under a significant storm event, the dam could release up to 30,000 cfs with the potential for minor flooding downstream. The hypolimnion would easily be flushed. If trout do not die from warm water temperatures, they may be flushed downstream during high dam releases to the Cumberland River where the water is significantly warmer. Warm water would benefit the mussels, but sustained high flows may dislodge them.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – Impacts of this alternative are similar to Alternative 8**.** Below EL 620, only the 4 sluice gates, with a combined discharge of approximately 4,800 cfs, could be used to lower the pool. The constant flow of warm water would be lethal to trout, and tiring to any fish that tried to stay in the tailwater. Continuous fast water would not be a problem for the mussels except the need for host fish.

4.8. Wetlands. The NWI indicates that wetlands are scarce around the shoreline of Center Hill Lake and therefore are not likely to be affected by any of the alternatives. But many small patches of emergent and forested/shrub wetlands line the tailwater of the Caney Fork River. Some of the interim pool alternatives and their associated tailwater discharge may affect tailwater wetlands and are described below.

- **Alternative 1**, (EL 648.0/623.5) No Action – Under this alternative, normal pool operation would maintain the tailwater wetlands. However, during dam repairs, a dam failure, and minimally, loss of the pool would eliminate downstream wetlands through scour, or burial by sediment.
- **Alternative 2**, (EL 645.0/623.5) – This alternative would maintain the tailwater wetlands with some reduced risk of dam failure that could destroy the wetlands.
- **Alternative 3**, Existing Condition, (EL 640.0/623.5) - This alternative would maintain the tailwater wetlands.
- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) – This alternative would maintain the tailwater wetlands.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.0) - This alternative would maintain the tailwater wetlands.
- **Alternative 6**, (EL 625.0/623.5) – This alternative would maintain the tailwater wetlands.
- **Alternative 7**, (625.0/618.0) - This alternative would maintain the tailwater wetlands.
- **Alternative 8**, Flat-line, (EL 622.0) – This alternative would likely have little effect on tailwater wetlands. Sporadic and prolonged high flows could scour some of them, but likely not more than what occurs under flood conditions.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – This alternative would likely have some affect on tailwater wetlands. Sporadic and prolonged high flows could scour some of them. A reduced flow could dry out the river bed, reducing wetland size. However, this situation is short-term and temporary. On dam repair completion, the condition of the riparian wetlands is expected to return to pre-repair condition.

4.9. Upland Habitat. Under a catastrophic dam failure, the Center Hill Lake pool, could scour or bury large areas under sediment downstream of the dam. The degree of damage would likely be linked to the elevation of the pool at the time of this unlikely event. A pool at EL 648 (Alternative 1) would likely produce the greatest damage with less damage and reduced risk of failure with each lower pool elevation alternative (2-9). Such damage would change the landscape that would take many decades to recover. Above the dam, no alternative would have a significant impact on upland habitat. However, with a long term drawdown of the lake, revegetation of the shoreline to the new water's edge would occur in the short term..

4.10. Wildlife Resources. Wildlife would be similarly impacted as upland habitat. Many animals could drown or be buried under sediment downstream of the dam. Such damage would impact population size that would take many years to recover. The loss of upland habitat could force surrounding wildlife to relocate such as fish eating raptors. Above the dam, no alternative would have a significant impact on wildlife. However, with a long term drawdown of the lake, animals may have to find alternate routes to drink from the lake.

4.11. Threatened and Endangered Species. Listed species occur in communities described under Aquatic Resources (Section 3.7), Upland Habitat (Section 3.10) and Wildlife Resources (3.11). The impact of each alternative on listed species would be the same as the impacts described for these resources under Sections 4.7, 4.10, and 4.11. A Biological

Assessment was completed, detailing listed species impacts and is attached as Appendix A. Screening down from the species list on the national U.S. Fish and Wildlife Service website, the Biological assessment considered 36 species in detail after species that no longer appear on the Cookeville and Frankfort Field Office county lists or that are known only from historic records (i.e. are considered extirpated) were eliminated from further consideration. In summary, the Biological Assessment supports determinations of “May Affect, but Not likely to Adversely Affect” for six endangered and one Candidate mussel species under the action alternatives, in general. The seven mussel species, listed in Table 5, above, are the Spectaclecase, Dromedary Pearlymussel. Cumberlandian Combshell, Catspaw (or Purple Cat's Paw), Pink Mucket, Ring Pink, and Orange-foot Pimpleback. The Biological Assessment supports “No Effect” determinations for the remainder of the species listed in Table 5. The Biological Assessment did not evaluate the No Action Alternative. However, in the event of a dam failure under the No Action Alternative there would likely be serious short term negative impacts to listed fish and mussel species, as well as other listed species situated in harms way from flooding.

4.12. Historic Properties - Archaeological, Historical, and Cultural Resources. Center Hill Dam and the facilities associated with the dam are considered eligible for listing in the National Register of Historic Places. Under Alternative 1, failure of the dam would result in the loss of a structure that is eligible for listing as well as eligible archaeological, historical, and cultural resources located and recorded downstream of Center Hill Dam. Under Alternatives 2-8, the risk of dam failure, which would damage or destroy the dam, is increasingly reduced. The potential loss of the pool under Alternative 1, and Alternative 9, Emergency Drawdown, would lower the lake enough to expose significant archeological sites that would be subject to erosion, vandalism and illegal collection of artifacts and objects. As long as the lake exists under Alternatives 2 – 7, the lowest pool elevations are well above the bottom of the power pool (EL 618) so as not to expose archeological sites that have not been accessible since creation of Center Hill Lake. These resources are not adversely affected as long as the lake remains above EL 618.

4.13. Environmental Justice. Any effects resulting from operational changes at Center Hill Dam would affect all human populations equally. In addition Public Meetings are planned to equally inform the public about the interim pool elevation alternatives. As a result, the requirements of this executive order have been met. The analysis concludes that for all alternatives, there were no disproportionate effects on minority or low-income populations.

4.14. Hydroelectric Resources. Some interim pool elevations would affect both hydro and thermal power generation. Hydropower relies on head pressure to run the turbines. Lower pool elevations reduce head pressure and increase the potential to damage the turbines. Reduced releases reduce the water flow needed by downstream thermal power plants for both generation and cooling. The impacts on these resources are described below.

- **Alternative 1**, (EL 648.0/623.5) No Action – Under this alternative, the high pool elevation (normal summer pool) would sustain hydropower and enough flow for downstream thermal power generation. However, during Center Hill Dam repairs, a dam failure or minimally, loss of the pool would eliminate hydropower and any releases that would support thermal power generation. A catastrophic Center Hill

Dam failure could severely damage Center Hill Dam, and Old Hickory Dam could be damaged by overtopping as well. Hydropower generation would be eliminated at both dams. Such a catastrophic event would also likely damage downstream thermal power plants.

- **Alternative 2**, (EL 645.0/623.5) – Under this alternative, the high pool elevation provides a large percentage of the water quantity needed to support hydropower during typical and wet years. During a dry year there would be some minor impact to hydropower peaking capability. Tailwater releases would likely augment the water flow needed by thermal power plants during typical and wet years. Some hydrostatic pressure on the dam would still exist.
- **Alternative 3**, Existing Condition, (EL 640.0/623.5) – Under this alternative, the high pool elevation would minimally provide enough water quantity with some minor impacts to hydropower peaking during a wet year. Typical and dry years would moderately impact hydropower providing little water to support continuous hydropower peaking abilities. Tailwater releases for thermal power would be similarly affected since it relies on the water releases during hydropower generation. However, hydrostatic pressure on the dam would be significantly reduced.
- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) – This alternative would have similar but worse impacts than Alternative 3. Hydropower peaking would be minimized during a typical and wet year, and noticeably reduced to critical peaking needs during a dry year.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/6218.0) - This alternative would have similar but worse impacts than Alternative 4. Hydropower peaking would be minimized in a wet year, and restricted to critical peaking needs during a typical and dry year.
- **Alternative 6**, (EL 625.0/623.5) – This alternative would have similar but worse impacts than Alternative 5. Hydropower peaking would be reduced to a few hours of critical peaking needs during any rainfall type year.
- **Alternative 7**, (625.0/618.0) - This alternative would have similar impacts to Alternative 6, but because it allows for a greater operating band it allows greater flexibility. Hydropower peaking would be reduced to a few hours of critical peaking needs during any rainfall type year.
- **Alternative 8**, Flat-line, (EL 622.0) – This alternative would have similar but worse impacts than Alternative 6. Hydropower generation would occur for only a few hours as water is released to augment flow for thermal power plants. A storm event would result in a sporadic and prolonged flow that could generate hydropower as water is released, but once this elevation is reached, water releases would likely stop. Zero releases would result in reduced generation from downstream thermal plants.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – Under this alternative, hydropower would be eliminated. The only way water can be released is through the sluice gates. No water would be released once the is reached. Zero releases would result in de-ratings to downstream thermal plants.

4.15. Flood Control. Flood control is a primary project purpose and under emergency operation, protection of the dam is the prime objective. Interim pool elevations would affect this purpose as follows.

- **Alternative 1**, (EL 648.0/623.5) No Action – Under this alternative, normal pool operation would maintain existing tailwater releases that attenuate high flood flows and maintain a minimum flow. However, during dam repairs, a dam failure, and minimally, partial or total loss of the pool would result in extensive damage of over $1.3 billion dollars to infrastructure and buildings downstream.
- **Alternative 2**, (EL 645.0/623.5) – This alternative is similar to Alternative 1 except the lower top elevation would relieve some hydrostatic pressure to reduce the risk of dam failure and loss of the pool. Reduced risk reduces the occurrence of flood damage.
- **Alternative 3,** Existing Condition, (EL 640.0/623.5) – Under this alternative, some water storage would be possible without increasing a significant risk of dam failure or loss of the pool due to hydrostatic pressure. This alternative would likely maintain the status quo of flood protection.
- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) – This alternative is similar to Alternative 3. A significant amount of water storage would be possible without increasing a significant risk of dam failure or loss of the pool due to hydrostatic pressure. This alternative would maintain the status quo of flood protection even during a wet year.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.0) – This alternative is similar to Alternative 4. A significant amount of water storage would be possible without increasing a significant risk of dam failure or loss of the pool due to hydrostatic pressure. This alternative would ensure maintenance of the status quo of flood protection even during a wet year.
- **Alternative 6**, (EL 625.0/623.5) – This alternative is similar to Alternative 5. A significant amount of water storage would be possible without increasing the risk of dam failure or loss of the pool due to hydrostatic pressure. However, this alternative would likely increase tailwater flows during any stormwater event because releases would have to be higher and longer than usual to maintain the top elevation, but no flood damage would be expected.
- **Alternative 7**, (625.0/618.0) - This alternative is similar to Alternative 5. A significant amount of water storage would be possible without increasing the risk of dam failure or loss of the pool due to hydrostatic pressure. However, this alternative would likely increase tailwater flows during and immediately after any stormwater event because releases would have to be higher and longer than usual to maintain the top elevation, but no flood damage would be expected. Due to the broader operating band it has the potential to offer even greater protection than alternative 6.
- **Alternative 8**, Flat-line, (EL 622.0) – This alternative is similar to Alternative 6. A significant amount of water storage would be possible as this alternative drastically reduces the risk of dam failure or loss of the pool. However, this alternative is expected to produce minor downstream flooding during any stormwater event because releases would have to be sudden, higher, and prolonged for an extended period of time to maintain this elevation.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – This alternative is similar to Alternative 7. A significant amount of water storage would be possible as this alternative drastically reduces the risk of dam failure or loss of the pool. However, this alternative is expected to produce prolonged, minor downstream flooding during

any stormwater event because releases would have to be sudden, higher, and nearly continuous for an extended period of time to maintain this elevation.

4.16. Water Supply. Water supply is a significant concern of the Center Hill project. Water supply storage has been reallocated at Center Hill Dam. The current users are the City of Cookeville, City of Smithville, and Riverwatch Resort.

- **Alternative 1**, (EL 648.0/623.5) No Action – Under this alternative, normal pool operation would maintain all the water intakes. However, during dam repairs, a dam failure, and minimally, partial or total loss of the pool would result in long-term loss of water supply in the lake and downstream of the dam.
- **Alternative 2**, (EL 645.0/623.5) – This alternative is similar to Alternative 1 except the lower top elevation would relieve some hydrostatic pressure to reduce the risk of dam failure and loss of the pool. Reducing risk would be more protective of the water supplies which would still be fully supported under this top elevation.
- **Alternative 3,** Existing Condition, (EL 640.0/623.5) – This alternative is similar to Alternative 2 except the lower top elevation would significantly relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool. Reducing risk would be more protective of the water supplies which would still be fully supported under this top elevation.
- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) – This alternative is similar to Alternative 3 except the lower top elevation would significantly relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool. Reducing risk would be more protective of the water supplies which would still be fully supported under this top elevation under any water year condition. There could be some minor water quality issues that would require some adjustments in water supply treatment.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.0) – This alternative is similar to Alternative 4 except the lower top elevation would relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool. Reducing risk would be more protective of the water supplies which would still be fully supported under this top elevation under any water year condition. There could be some minor water quality issues that would require some adjustments in water supply treatment. The bottom elevation would be close to the intake elevations of the municipal water and pumps could pull in air. However, intakes can be extended to eliminate this problem
- **Alternative 6**, (EL 625.0/623.5) – This alternative is similar to Alternative 5 except the lower top elevation would significantly relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool. Reducing risk would be more protective of the water supplies which would still be fully supported under this top elevation under any water year condition. There could be some major water quality issues that would require significant adjustments in water supply treatment.
- **Alternative 7**, (625.0/618.0) - This alternative is similar to Alternative 6 except the bottom elevation would be close to the intake elevations of the municipal water intakes. Even though the intakes would still have at least two feet of water above them, if the water was drawn down to 618 the intake could create a vortex to the surface which would pull air and trash into the system. In addition, as the water

becomes lower and warmer, there could be some major water quality issues that would require significant adjustments in water supply treatment.

- **Alternative 8**, Flat-line, (EL 622.0) **–** This alternative is similar to Alternative 6 except the lower top elevation would drastically relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool. Reducing risk would be more protective of the water supplies which would still be fully supported under this top elevation under any water year condition. There could be some major water quality issues that would require significant adjustments in water supply treatment particularly downstream of the dam. During any stormwater event, releases would have to be sudden, higher, and prolonged for an extended period of time, and then restricted to maintain this elevation.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) **–** Under this alternative, water supply would be eliminated in Center Hill Lake since the lowest intake is located at EL 616. Nearly 50,000 people would be without water in addition to the lack of water for fire fighting. This alternative is expected to negatively impact the tailwater intake water treatment since it would produce sudden, higher, and nearly continuous for an extended period of time followed by no flow to maintain these elevations.

4.17. Air Quality. All alternatives would have virtually no impact on air quality.

4.18. Noise. No alternative would have a significant impact on noise levels.

4.19. Recreation. Recreation was not originally an authorized purpose of Center Hill Dam and Lake, but was added in 1965. The recreation areas in the study area are classified as campgrounds, picnic areas, beaches, boat ramps, and marinas. Of the 37 ramps available, 2 are closed resulting in a total of 35 ramps that would be affected. Recreation would be affected not only by the number of usable ramps but the reduced window of time these ramps would be available. Fewer people recreate during the winter when the lake is normally maintained at lower levels. Historically, the lake levels reach 623.5 from a few weeks to a few months in the winter and then hover around the upper boundary of the winter PMB (632.0) during the remainder of winter. The public heavily uses the lake during the summer and is accustomed to a summer pool of EL 648. At some pool elevation, reduction in the summer pool will expose the unknowing public to navigation hazards. The impact of the interim pool elevations on recreation are described below.

- **Alternative 1**, (EL 648.0/623.5) **–** Under this alternative all recreational areas would be sustained during the summer months. However, EL 623.5, results in 5 ramps being usable, 3 marginal, and 27 being unusable. At the more common winter pool, EL 632.0, 28 of the 35 launching ramps are usable. However, during dam repairs, a dam failure, and minimally, partial or total loss of the pool would likely result in loss of all recreational areas both upstream and downstream of the dam.
- **Alternative 2**, (EL 645.0/623.5) **–** Under this alternative, all boat ramps would still be useable during the summer months under EL 645.0. An extended winter pool of EL 623.5 would have the same effects as Alternative 1. This alternative would relieve some hydrostatic pressure to reduce the risk of dam failure and loss of the pool Reducing risk would be more protective of recreational areas

- **Alternative 3,** Existing Condition, (EL 640.0/623.5) – This alternative is similar to Alternative 2. All boat ramps would still be useable during the summer months at EL 640. Ramp impacts would be the same as Alternative 1 at EL 623.5. This alternative would relieve more hydrostatic pressure than Alternative 2.
- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) – This alternative is similar to Alternative 3, except the impact is worse. At a summer EL 635.0, all four swimming beaches would be unusable. Also, 31 boat ramps would be useable, 1 marginal, and 3 would be unusable. At EL 623.5, the impacts are the same as Alternative 1.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.0) – This alternative is similar to Alternative 4, but worse. At a summer pool of EL 630.0, 21 boat ramps would be useable, 4 marginal, and 10 would be unusable. At EL 618, no launching ramps would be usable. At least two of the nine commercial marinas would have to relocate portions of their facilities and one marina, that is currently approved to relocate to a new site, would be required to accelerate their planned relocation.
- **Alternative 6**, (EL 625.0/623.5) –This alternative would result in a near year-round winter pool. There would be major impacts in the number of usable boat ramps. At EL 625.0, 5 boat ramps would be useable, 7 marginal, and 23 would be unusable. All swimming beaches would be unusable. Two of the nine commercial marinas would have to relocate portions of their facilities and one marina, that is currently approved to relocate to a new site, would be required to accelerate their planned relocation. Approximately 10 of the 28 privately permitted boat docks would be unusable. Major navigation hazards, such as mud or rock bottom surfaces and debris, common in the winter, would be exposed during the summer months of high recreation use. This situation exposes the public to a high rate of accidents. Impact during the winter pool of EL 623.5 would be the same as in Alternative 1.
- **Alternative 7,** (EL 625.0/618.0) – The impacts of this alternative are the same as Alternative 6 but, worse at EL 618.0. At the low winter elevation (618.0), all boat ramps would be unusable. Marinas would have to reconfigure or move. A large number of additional major navigation hazards, would be exposed; such as mud or rock bottom surfaces and debris. The 40 fish attractors placed by the Tennessee Wildlife Agency (TWRA) would have to be moved in deeper water.
- **Alternative 8**, Flat-line, (EL 622.0) – This alternative is similar to Alternative 6 except the impact is more severe. At this elevation, 2 launching ramps would be usable, 2 marginal, and 31 would be unusable. All swimming beaches would be unusable. At least two of the nine commercial marinas would have to relocate portions of their facilities and one marina, that is currently approved to relocate to a new site, would be required to accelerate their planned relocation. Approximately 10 of the 28 privately permitted boat docks would be unusable. Major navigation hazards, such as mud or rock bottom surfaces and debris, common in the winter, would be exposed during the summer months of high recreation use. During any stormwater event, releases would have to be sudden, higher, and prolonged for an extended period of time exposing fishermen in the tailwater to high water releases. This situation exposes the public to a high rate of accidents.

- **Alternative 9**, Emergency Drawdown, (EL 618-496) – Under the top elevation of 618, impacts would be the same as noted in Alternative 7. At EL 496.0, the lake would be drained. All recreation would be eliminated.

4.20 Aesthetics. The Center Hill Lake watershed is known for its scenic and natural qualities (TDEC, 1998). Caney Fork River and many of its tributaries wind through rugged gorges lined with limestone ledges, cliffs, and bluffs. Aesthetics address the viewshed of both Center Hill Lake and the landscape downstream of the dam. Under Alternative 1 – No Action, the viewshed would not be affected, unless, during dam repairs, a dam failure, and minimally, partial or total loss of the pool occurs. Under this scenario, Center Hill Lake would resemble a river running through bare earth and rock. Downstream of the dam, the landscape would be scoured or buried under sediment Such damage would change the landscape that would take many decades to recover. All other alternatives would have little affect on the viewshed upstream or downstream of the Center Hill Dam.

4.21. Economics. The Center Hill Project provides numerous economic benefits not only to the local economy but to the region as well. Such benefits include, jobs, taxes, land values, recreation, hydropower and cooling water for thermal power plants, navigation, water supply, and flood protection. The degree of impact to the economy associated with each alternative is described below.

- **Alternative 1**, (EL 648.0/623.5) No Action – Under this alternative, the local and regional economy would be sustained. However, during dam repairs, a dam failure, and minimally, partial or total loss of the pool would likely result in economic hardship both upstream and downstream of the dam. Downstream flood and infrastructure damage could exceed $1.3 billion dollars. The economic loss of the lake could exceed $ 109 million annually.
- **Alternative 2**, (EL 645.0/623.5) – This alternative is similar to Alternative 1. All economic benefits would be sustained at this top pool elevation. The lower top elevation would relieve some hydrostatic pressure to reduce the risk of dam failure and loss of the pool. Reducing risk would increase protection against economic losses.
- **Alternative 3,** Existing Condition, (EL 640.0/623.5) – This alternative is similar to Alternative 2. The lower top elevation would significantly relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool. All economic benefits would be sustained at this top pool elevation with some minor impacts. The time window (summer season) for generating these annual benefits could be slightly reduced.
- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) – This alternative is similar to Alternative 3, except economic impacts would be increased in Center Hill Lake. There would be impacts to visitation at Center Hill Lake with closure of all 4 beaches. At this top pool elevation 31 of 35 boat ramps would be usable. Marinas would remain open. The lower top elevation would significantly relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.0) – This alternative is similar to Alternative 4, except economic impacts would be more noticeable in Center Hill Lake. All 4 beaches would be closed. At the top elevation, 21 of the 35 boat ramps would be useable. At the lower elevation, 5 ramps would be useable, 3 marginal, and 27 would be unusable. Many boat ramps,

where possible, would need to be extended for safe lake access. Marinas would remain open, but some may have to re-configure their boat slips, or possibly move to another location. The lower elevation would significantly relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool reducing the risk of incurring 1.3 billion dollars in damages downstream of the dam.

- **Alternative 6**, (EL 625.0/623.5) – This alternative is similar to Alternative 5, except economic impacts would be greater in Center Hill Lake. Nearly a third of the annual income (36 million dollars) generated by the Lake would be lost. A one-time loss of $283 million is projected, although jobs may recover when normal pool levels return. The lower top elevation would dramatically relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool reducing the risk of incurring 1.3 billion dollars in damages downstream of the dam.
- **Alternative 7**, (625.0/618.0) – As in alternative 6, economic impacts would be greater. Nearly a third of the annual income (36 million dollars) generated by the Lake would be lost. A one-time loss of 283 is projected. Jobs may recover when normal pool levels return. The lower elevation would reduce the risk of dam failure and the risk of incurring 1.3 billion dollars in damages downstream of the dam.
- **Alternative 8**, Flat-line, (EL 622.0) – This alternative is similar to Alternative 6, except economic impacts would be more severe in Center Hill Lake. Over half of the annual income (60 million dollars) generated by the Lake would likely be lost. A one-time loss of 283 is projected, although jobs may be recovered when normal pool levels return. The lower top elevation would dramatically relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool reducing the risk of incurring 1.3 billion dollars in damages downstream of the dam. Revenue from the tailwater fishery, which generates over one million annually, would likely be impacted. During any stormwater event, releases would have to be sudden, higher, and prolonged for an extended period of time significantly reducing fishing in the tailwater during high water releases.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – Under this alternative, all project purposes are severely impacted or eliminated. The immediate economic impact would be total, start locally, and ripple through the regional economy. Total annual losses related to recreation could reach $ 109 million for lost visitations, trip spending, personal income, trout fishing, federal, and state taxes. Annual hydropower loss to the federal treasury would exceed $ 14 million. And annual loss of water supply and fire protection would exceed several millions of dollars. However, this elevation would dramatically relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool reducing the risk of incurring 1.3 billion dollars in damages downstream of the dam.

4.22. Navigation. A nine-foot commercial navigation channel on the Cumberland River is generally supported by the maintenance of full, flat pools and minimum tailwater elevations at the four main-stem projects (Barkley, Cheatham, Old Hickory, and Cordell Hull Lock and Dams. Tows are dependent on favorable release schedules to transit reaches below the navigation projects. Although navigation is not an authorized project purpose, releases from Center Hill Dam for other project purposes (minimum flow and water quality) do contribute to the available flows. There are navigation impediments in the approaches to both Old

Hickory and Cheatham Locks than can effect navigation. Possible impacts to navigation are noted below

- **Alternative 1**, (EL 648.0/623.5) – Under this alternative, navigation throughout the Cumberland River would be sustained. However, during dam repairs, a dam failure, and minimally, partial or total loss of the pool would likely result in severe economic impacts downstream of Center Hill Dam. Flooding would damage downstream infrastructure including ports, commercial terminals, locks, TVA fossil plants, and other water related businesses. Debris would likely accumulate in the navigation channel prohibiting safe passage for an extended period of time. Such an event would eliminate moving commodities such as coal to the TVA Gallatin and Cumberland Steam Plants. Without electricity provided by the steam plants, rolling blackouts could occur with the loss of power. This alternative does little to reduce hydrostatic pressure on the dam nor reduce the risk of dam failure during dam repairs.
- **Alternative 2**, (EL 645.0/623.5) – This alternative is similar to Alternative 1. All navigation benefits would be sustained at this top pool elevation. This top elevation (EL 645) would relieve some hydrostatic pressure to reduce the risk of dam failure and loss of the pool. Reducing risk would increase protection for navigation benefits.
- **Alternative 3,** Existing Condition, (EL 640.0/623.5) – This alternative is similar to Alternative 2. The lower top elevation (EL 640) would significantly relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool. All navigation benefits would be sustained at this top pool elevation with some minor impacts. The time window for providing a navigation window of safe transit through Cheatham and Old Hickory Locks could be slightly shortened.
- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) – This alternative is similar to Alternative 3, except navigation impacts could be moderate. This alternative would probably result in further shortening the windows of opportunity for barge traffic to maneuver through Cheatham and Old Hickory Lock approaches. The lower top elevation would significantly relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.0) – This alternative is similar to Alternative 4, except economic impacts could be more with less water available for project uses such as minimum flows and water quality, which means less flow to augment navigation needs. Small transit windows would likely occur. However, with a wide band of nearly 18 feet of stored water, there may be some flexibility to meet critical water releases downstream (i.e., water quality) which would help navigation. The time window for providing a navigation window of safe transit through Cheatham and Old Hickory Locks could be shortened to a matter of hours. The upper and lower elevations would significantly relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool.
- **Alternative 6**, (EL 625.0/623.5) – This alternative is similar to Alternative 5, except navigation impacts would be greater, but still moderate in nature. There would be less water available for releases during drier months. There is the potential that barges may have to re-configure or light-load to move past navigation impediments at Cheatham and Old Hickory Locks. The lower top elevation would dramatically relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool.

- **Alternative 7**, (625.0/618.0) – As in alternative 6, navigation impacts would be moderate. There would be less water available for releases during drier months. **Alternative 8**, Flat-line, (EL 622.0) – This alternative is similar to Alternative 6, except navigation impacts would be more severe. The lower top elevation would dramatically relieve hydrostatic pressure to reduce the risk of dam failure and loss of the pool. During any stormwater event, releases would have to be sudden, higher, and prolonged for an extended period of time significantly impacting navigation downstream.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – Under this alternative, all project purposes are severely impacted or eliminated. Navigation would also be affected. The immediate economic impact would be total, start locally, and ripple through the regional economy.

4.23. Hazardous, Toxic, or Radiological Wastes. No alternative would result in HTRW concerns except Alternative 1 – No Action. During dam repairs, a dam failure, and minimally, partial or total loss of the pool would likely damage and expose HTRW sites downstream of the dam.

4.24Traffic. No alternative would result in changes to traffic patterns except Alternative 1 – No Action. During dam repairs, a dam failure, and minimally, partial or total loss of the pool would result in closure of Highway 96 crossing the dam. Traffic would have to detour around Center Hill Lake which would increase travel distance by at least 15 miles.

4.25. Safety. One of the authorization purposes for constructing Center Hill Dam was to reduce the loss of lives and property from downstream flooding. An important consideration regarding safety is to determine if the reduction in hydrostatic pressure to reduce the risk of dam failure or loss of the pool, outweighs the ecological and economic impacts that would occur by lowering the lake. The impact on safety is described below.

- **Alternative 1**, (EL 648.0/623.5) No Action – Under this alternative, the high risk of dam failure virtually eliminates any safety from downstream flood or upstream and downstream drought. Under Alternative 1, dam failure or loss of the pool would result in severe repercussions (EPA, 2007.) including: 1.) loss of life from surging flows, 2.) destruction of property, 3.) harm to the downstream river environment, 4.) risks of life threatening hazards to river users, and 5.) loss of delivery of critical services to communities with the loss of power generation, roads, bridges, and other infrastructure.
- **Alternative 2**, (EL 645.0/623.5) – This alternative is about 3 feet below normal summer pool. This alternative reduces the risk of dam failure and increases safety. However, EL 645.0 does not provide much additional storage to maintain low hydrostatic pressure on the dam during significant storm events over an extended period of time.
- **Alternative 3**, Existing Condition, (EL 640.0/623.5) - This alternative is about 8 feet below normal summer pool. This alternative reduces the risk of dam failure and greatly increases safety. A significant storm event could raise the pool several feet, but the initial low pool would maintain low hydrostatic pressure. During drought, this elevation ensures a water supply for fire fighting to upstream and downstream uses.

- **Alternative 4**, **Environmentally Preferred Alternative,** (EL 635.0/623.5) – This alternative is about 13 feet below normal summer pool. This alternative would have the same effect as Alternative 3 but with a reduction in risk and increased dam safety.
- **Alternative 5**, **Dam Safety and Engineering Preferred Alternative,** (EL 630.0/618.0) - This alternative is about 18 feet below normal summer pool. This alternative would reduce risk and increase dam safety. The pool could hold a significant storm event with little increase in risk.
- **Alternative 6**, (EL 625.0/623.5) – This alternative is about 23 feet below normal summer pool. This alternative would reduce risk and increase dam safety. The pool could hold a significant storm event with little increase in risk.
- **Alternative 7**, (625.0/618.0) - This alternative is about 23 feet below normal summer pool. This alternative would reduce risk and increase dam safety. The pool could hold a significant storm event with little increase in risk.
- **Alternative 8**, Flat-line, (EL 622.0) – This alternative is about 26 feet below normal summer pool. This alternative would reduce risk and increase dam safety. The pool could hold a significant storm event with little increase in risk. During drought, this elevation would likely restrict water supply for fire fighting to upstream and downstream users.
- **Alternative 9**, Emergency Drawdown, (EL 618.0/496.0) – This alternative is 78 ft below the congressionally authorized minimum pool elevation of EL 618.0; and 108 ft below normal summer pool (EL 648.0). This alternative would reduce risk and ensure dam safety the most. The pool could hold a significant storm event with little increase in risk. This elevation would eliminate potable water supplies in Center Hill Lake and any fire fighting ability to upstream and downstream users.

4.26. Floodplain Management. The No Action alternative (1) would have a high risk of a "base flood" and catastrophic impact to the floodplain. In the event of a dam failure during the 7-year dam repair period, the Caney Fork and Cumberland River floodplains downstream of Center Hill Dam would be radically altered. The rock features would remain intact, but the riparian and adjacent floodplain vegetative cover would likely be scoured or buried under deposited sediment. The risk of dam failure decreases incrementally with each successive alternative. Dam repairs and lowering hydrostatic pressure on the dam with lower top pool elevations for an extended period is necessary to minimize potential dam failure and reduce risk to downstream populations. There is no practical alternative to working in the Caney Fork River and floodplain.

4.27. Cumulative Effects. Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the (proposed) action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions (40 CFR 1508.7)". Council for Environmental Quality (CEQ) guidance identifies an 11-step process for evaluating cumulative effects. For the purposes of cumulative effects, the spatial boundary includes Center Hill Lake and the Caney Fork River tailwater (26.4 miles) to the confluence of the Cumberland River (mile 309) downstream to Barkley Dam at Cumberland River mile 30.7. The temporal boundary covers the past 60 years, after impoundment of Center Hill Lake, and 10 years into the future, on completion of dam repairs. These boundaries were selected because they cover the entire

Center Hill project and its impact to the Cumberland River System. Past, present, and foreseeable actions that could combine for cumulative effects include, dam safety considerations, weather, human population growth, and land and water developments.

The assessment can be defined as "what resource goals is the proposed action going to affect". Effects can result from either direct-project related, indirect-project related, and independent indirect causes. Based on public and agency scoping and review on previous NEPA documents, the following resources have been identified as target resources within the assessment goals: 1.) Water quantity, 2.) Hydropower, 3.) water supply, 4.) water quality, 5.) aquatic resources including threatened and endangered fish and freshwater mussel species, 6.) socioeconomics, 7.) recreation/tourism, 8.) river navigation.

Water Quantity. For the purposes of cumulative effects, the spatial boundary is located from the headwaters of Center Hill Lake, just below Great Falls Dam (Caney Fork River mile 91.1) to the confluence of the Cumberland River (mile 309) downstream to Barkley Dam at Cumberland River mile 30.7. The temporal boundary covers the past 60 years, after impoundment of Center Hill Lake, to 10 years into the future, when dam repairs are completed. Demands for this resource include withdrawals for municipal and industrial purposes, hydropower generation, water quality, aquatic resources including threatened and endangered species, recreation, and to a lesser degree, maintaining commercial navigation. Weather conditions, such as drought or storm events, also affects water quantity. A key component of water quantity is water temperature that affects the amount of cold water stored within the reservoir. Cold water is particularly in demand because it retains more dissolved oxygen, supports a cold water fishery, and is necessary to maintain water quality for downstream thermal plants. In particularly wet years, warm rain may produce a large enough volume of warm inflowing water that may raise lake temperatures and dilute the available cold water stored in the hypolimnion. During dry years, the quantity of cold water is finite. Lowering Center Hill Lake reduces the amount of cold water and retention time. Historically, under normal operations, there has been sufficient cold water to meet demands. Lowering the lake level is likely to result in insufficient storage of cold water. Lack of cold water could result in decreased water quality since cold water holds more oxygen. Negative impacts to aquatic resources, including threatened and endangered species could occur, as low DO could affect the warmwater fishery in the Cumberland River, and the trout fishery in the tailwater of the Caney Fork River. Warm water, even if well oxygenated, is lethal to trout. Lack of water reduces hydropower generation, and insufficient cold water reduces the cooling requirements of the thermal plants, which may lead to reduced electrical production. Lack of water could limit navigation downstream. If Center Hill was the only reservoir affected then the other nine reservoirs of the Cumberland River system could meet most of the needs. However, when more than one storage reservoir is affected by lower lake levels, then there may not be enough water to meet the demands of all users. Potential impacts could include rolling black-outs due to insufficient thermal power generation, grounded barges, fish kills, and damage to the regional economy. Loss of power, even temporary, could have detrimental effects on human health. Potable water systems could loose pressure forcing a boil-water advisory. Sewage treatment plants could malfunction, resulting in discharge of untreated waste water into rivers and lakes. Transportation effects would include highway traffic gridlock, and shutting down gas stations, railways and airports. The loss of power would affect hospitals, fire stations, schools, stores, and industry. Cellular communication services could be disrupted. This situation could jeopardize public safety and welfare. Mitigation measures might include a prioritization of water uses. A drought contingency plan has already been developed to cover such exigencies. Mitigation measures under the drought contingency plan were implemented during the extreme to exceptional drought of 2007, and the impacts discussed above were avoided. While there are no guarantees of future weather conditions, the mitigation measures under the drought contingency plan are expected to adequately address these impacts. Water quantity would be constantly monitored and the situation would be continuously reassessed. On completion of dam repairs, Center Hill Dam would return to the status quo condition of supporting all project purposes including it's flow contribution to the Cumberland River Reservoir system. The cumulative effect of the completion of both Center Hill and Wolf Creek Dams would return the Cumberland River system to pre-repair condition.

Hydropower. For the purposes of cumulative effects, the spatial boundary coincides with the SEPA power grid. The temporal boundary covers the past 60 years, after impoundment of Center Hill Lake, to 10 years into the future, when dam repairs are completed. Demands for this resource include peaking power at Center Hill Dam and its contribution to the power grid. Demands for the water used for hydropower include water for minimum flow, water quality, fish and wildlife management, and recreation. Under minimum flow releases, hydropower generation adds little oxygen to improve downstream water quality to support the cold water fishery. Instead, water for hydropower is diverted through a sluice gate to meet both minimum flow and water quality needs. Lowering the lake reduces the amount of water available for hydropower. When lake levels reach EL 620, no hydropower is generated. Because of the lack of hydraulic pressure at lower lake levels, generating hydropower below EL 620 endangers the equipment. Historically, under normal operations, the high summer lake level easily provided sufficient hydraulic pressure for hydropower peaking needs and excess power could be sold on the power grid. During the winter pool, winter and spring rainfalls were captured and stored, often to EL 632 and higher, and released by hydropower generation to produce excess and cheap electricity to the grid. Lowering the lake would reduce hydropower generation, and at a low enough pool, eliminate hydropower generation. Under this condition, power would have to be bought from another source to supply electrical power to the grid which is likely to raise costs to the local utilities and ultimately, their customers. The higher cost of electricity could force local businesses to reduce production and cut jobs, which would impact the local economy. If Center Hill was the only reservoir affected by low lake levels, the other nine dams could meet the hydropower needs, however, when more than one dam is affected, more electricity has to be bought to supply the power grid. The cumulative effect of the high cost of electricity on a regional scale would likely reduce business production, cut jobs, and negatively impact the regional economy. When dam repairs are complete, hydropower generation would be expected to return to status quo condition at Center Hill Dam and its contribution to the power grid.

Water Supply. For the purposes of cumulative effects, the spatial boundary covers Center Hill Lake, Center Hill Dam, and the downstream tailwater (26.4 miles) to the confluence of the Cumberland River (mile 309) downstream to Barkley Dam at Cumberland River mile 30.7. The temporal boundary covers the past 60 years, after impoundment of Center Hill

Lake, to 10 years into the future, when dam repairs are completed. There are three water supply intakes on Center Hill and they are all located below the bottom of the power pool (EL 618). Other demands for water include hydropower, water quality, aquatic resources, and minimum flow in the tailwater. Under normal operations, there has been abundant water of good quality to fully meet water supply demands. Low lake levels would provide only a few feet of water coverage over the intakes in Center Hill Lake, and the potential to create a vortex to the surface which would pull air and trash into the system. Algae and low flows may cause higher water treatment costs to control taste and odor problems in drinking water supplies, not only in Center Hill Lake, but throughout the entire downstream length of the Cumberland River. Water utilities may need to enforce water restrictions. As population increases over the next 10 years, so will demands for water supply. Wolf Creek Dam is also undergoing repairs and can not contribute water to the system to meet water demands. It is unlikely that Dale Hollow would be able to make-up for the lack of water to meet all the demands. During the next 10 years, water rationing is more likely to be required in portions of the Cumberland River system under prolonged exceptional drought conditions and if lake levels in Wolf Creek and Center Hill Dams remain reduced. A mitigation measure for water supplies drawn from Center Hill Lake would be to lower water intakes deeper into the pool. Mitigation measures might include a prioritization of water uses. A drought contingency plan has already been developed to cover such exigencies. Water supply would take priority over all other purposes to protect human life and welfare. Water supplies would be constantly monitored and the situation would be continuously reassessed. On completion of dam repairs at both Center Hill and Wolf Creek Dam, water can be stored to meet current and projected water supply demands.

<u>Water Quality</u>. For the purposes of cumulative effects, the spatial boundary covers Center Hill Lake, Center Hill Dam, and the downstream tailwater (26.4 miles) to the confluence of the Cumberland River (mile 309) downstream to Barkley Dam at Cumberland River mile 30.7. The temporal boundary covers the past 60 years, after impoundment of Center Hill Lake, to 10 years into the future, when dam repairs are completed. Demands for this resource includes, aquatic resources including threatened and endangered fish and freshwater mussels, water supply, and recreation. Weather conditions, such as drought or storm events, also affect water quality. Water temperature is addressed above under “Water Quantity”. While water temperature affects the type of aquatic community present (cold, cool, or warm water fisheries) all aquatic life requires adequate dissolved oxygen. Oxygen is the second key component of water quality that is considered under this section. Historically, DO in Center Hill Lake and in the tailwater below the dam, was sufficient to maintain fish and freshwater mussels. Lower lake levels could change the water quality in Center Hill Lake and in the tailwater. Dissolved oxygen and appropriate water temperature is critical in maintaining the health of aquatic organisms, including threatened and endangered species. For warm water species, a DO of 5 mg /l is required for the lake fishery. The tailwater trout fishery below the dam requires a DO of 6 mg/l to maintain healthy populations. Cumulative impacts on dissolved oxygen could occur in several ways. Center Hill Lake water quality is affected by watershed development, point and nonpoint sources of pollution that enter the lake resulting in added nutrients and biological oxygen demand that can seriously reduce oxygen in the lake to the point of producing fish and mussel kills. The tailwater draws cold water from the bottom of the lake. As a result of the lost oxygen in the lake, the tailwater contains little or no oxygen. Operational and structural changes at the dam are needed to improve water quality and replace oxygen in the tailwater by opening a sluice gate, or future installation of an orifice gate. Without these engineered changes, the Center Hill tailwater would remain deficient of oxygen during critical summer months. Lower lake levels could result in drawing warmer water from the lake, which holds less oxygen, therefore oxygen added at the dam, may dissipate by the time it reaches the Cumberland River. The combined lower lake levels in both Center Hill and Wolf Creek Dams can have a cumulative effect that could result in decreased water quality and development of anoxic conditions downstream the entire Cumberland River. Under drought conditions, the potential for cumulative anoxic conditions increases in the Cumberland River for a limited time, during late July and August as a result of longer retention times as compared to historical flow regimes. Mitigation measures at Center Hill include maintaining a minimum flow, installing an orifice gate, or continue to sluice. Add these measures in addition to spilling at the mainstem dams (Cordell Hull, Old Hickory, and Cheatham Lock and Dams) and the cumulative effect appears to reduce low dissolved oxygen effects. In fact, during the extreme to exceptional drought of 2007, the impacts discussed above were avoided. While there are no guarantees of future weather conditions, the mitigation measures are expected to adequately address these cumulative water quality impacts. In the next 10 years, human development around Center Hill Lake, as well as in the Cumberland River are likely to increase resulting in increased point and nonpoint sources of pollution. Ensuring point sources meet their discharge requirements, and preventing nonpoint sources from entering the waterways would do much to preserve the water quality of Center Hill Lake and downstream the Cumberland River.

Aquatic Resources, Including Threatened and Endangered Fish and Freshwater Mussels. Since its impoundment about 60 years ago, Center Hill has significantly altered the hydrology and water quality both of the lake and to areas as far downstream as the Ohio River. The geographic scope of this section, therefore, is all of Center Hill Lake, the Caney Fork River below the dam to its confluence with the Cumberland River, and the Cumberland River downstream to Barkley Dam. The temporal boundaries are from the impoundment of Center Hill in 1948 when all of the changes to the waterway became permanent, to fifty years in the future. Because of the size and depth of Center Hill Lake, the water regime quickly became a cold water system downstream of the dam. The native warm water species below Center Hill Dam have been largely displaced by cold water species including trout which are stocked in the Caney Fork tailwater on a put-grow-and-take basis. The mussels of the Caney Fork River, which were unable to move, died because they could not adapt to lake conditions, or due to the cold water released below the dam, were unable to reproduce. Mussel surveys over the last 20 years reveal that many mussels have largely died out although a few relic species may yet remain. Because of the year round low water temperatures below Center Hill Dam, this portion of the Caney Fork River has been classified as a trout stream. Impoundment of the other dams also extirpated many species throughout much of their reaches. The exception is in the tailwater areas which are similar in habitat to the original river. In addition to the cold water, the greatest stress on these animals is water quality, or the lack thereof. As Center Hill and Wolf Creek are drawn down during repairs, there will be less flow in the rivers during the summers. A warmer water regime would return, but would likely be accompanied by poorer water quality. As water temperatures increase, so too would algal blooms. As the algae dies, the DO could be reduced to near zero. As Tennessee’s population increases and more and more of the areas around the reservoirs are developed, it is expected that future nutrient loading, which supports algal growth, will increase and DO in the tailwaters will decrease. The cool water and the native warm water ecosystem could then see fish kills and major die-off of the macroinvertebrate community. Seven species of Federally-listed endangered species have been identified as possibly being affected, but not likely to be adversely affected, by these changes. Several methods of mitigation discussed elsewhere in this document appear to have mitigated the situation during the extreme to exceptional drought of 2007. After the repairs have been effected the dams would be returned to full service and conditions such as reverting to a cold water regime would again be in place for the foreseeable future. Under this scenario, it would likely take years for the lake fishery to recover.

Recreation/Tourism. For the purposes of cumulative effects, the spatial boundary covers Center Hill Lake, Center Hill Dam, and the downstream tailwater (26.4 miles) to the confluence of the Cumberland River (mile 309). The temporal boundary covers the past 60 years, after impoundment of Center Hill Lake, to 10 years into the future, when dam repairs are completed. Demands on this resource include, water supply, water quantity, water quality, and aquatic resources including endangered species. Under normal operations, customary summer and higher winter pool (above El 632) can be easily maintained. The winter pool can be slightly elevated for easier access into the lake, and increased water supply for hydropower, and increased cold water storage for other uses. Though some boating occurs in the winter, recreation activities (boating, camping, and swimming) predominantly occur during the warm summer months, creating a recreational season. Therefore recreation is most impacted when lake levels are lowered during the summer pool, though some impact would occur during the winter months. These recreation users have an economic impact on the local and regional economy. Lower lake levels, would affect access to the lake, marina operations, and safe boating and fishing. At particularly low lake levels, swimming beaches, boat ramps, boat slips, and some private docks are unusable. Lost access to the lake reduces recreational use which impacts income generated at the lake and the local economy. A loss of nearly 100 million dollars annually could be seen under this condition. During the 7-10 year dam repairs, maintaining very low lake elevations could result in several hundred millions of dollars of lost revenue. Couple a low lake pool with drought conditions, possible critical hydropower releases, continued water supply withdrawals, and minimum flow requirements for water quality, the lake could remain or even fall lower for an extended period of time even throughout the summer months resulting in economic hardship for the local economy. The cumulative effect of low lake conditions at both Center Hill and Wolf Creek Dams could result in economic hardship for the regional economy. Dale Hollow Lake may also be lowered as it attempts to supply nearly all the water to the Cumberland River system. Though the effects would be temporary, possibly occurring through the entire dam repair period, it could take years to recoup the financial losses. Mitigation efforts may include extending boat ramps, both in the lake and below the dam, re-configuring boat slips, relocating marinas into deeper water around the lake. Over the next 10 years, recreational demands and development pressures will increase, yet the total amount of public land and water remains fixed. Land around the lakes is expected to become increasingly urbanized. There will be increasing pressure for more water related recreation. Balancing the needs of recreation with other project uses will become the challenge. Water resources must be managed in the interest of public health as constant pressure tips the balance toward other interests of the growing population: more water control for water supply, water quality, hydropower, and navigation, in addition to more access for outdoor recreation. On completion of Center Hill Dam repairs (7-10 years) routine operations would be restored along with a customary summer and winter pool elevations. Completion of Wolf Creek Dam repairs (7-10 years) and maintaining the storage pool at Dale Hollow Dam would have the cumulative effect of restoring the status quo of recreation throughout the region.

Navigation. The geographic scope of this section is from Cordell Hull Dam, immediately upstream the confluence of the Caney Fork River and the Cumberland River, downstream to the Ohio River. The temporal period begins in the 1950s when the Cumberland River mainstem lock and dams were constructed and ranges out to about fifty years in the future. A nine-foot commercial navigation channel on the Cumberland River upstream of Barkley Dam is generally supported by the maintenance of full, flat pools and minimum tailwater elevations at the four main-stem dams (Barkley, Cheatham, Old Hickory, and Cordell Hull). Several factors affect navigation including regional economics and ease of passage. Navigation is not a project purpose at Center Hill. Under normal operations, tailwater releases augment flow in the Cumberland River. During periods of low flows, navigation of fully loaded barges can become problematic, particularly as the barges enter the tailwater areas below the locks as these are normally some of the shallowest areas of the river. Water releases from the upstream tributary lakes are usually sufficient to keep the navigable reservoir levels above the inactive pools in the mainstem. However, as Wolf Creek and Center hill undergo repairs, the lack of stored water which is usually released during the summer for hydropower and other project functions may be lacking. Without these customary flows navigation may become difficult. In the past this has resulted in limiting passage to certain windows of opportunity, i.e., releases are scheduled for predetermined times. As water flow drops these windows become shorter in duration and farther apart. Some companies "light load" their barges so that they draft less water and can still pass the shallow areas. Sometimes cargo is diverted to other means of transportation such as trains or trucks. This is usually more expensive, but by saving time may become more economical for some products. Once alternative forms of transportation are found is can be hard for shippers to reclaim their business. It is assumed that after repairs to the dam are effected in seven to ten years that normal operations would resume for the foreseeable future.

Socioeconomics. For the purposes of cumulative effects, the spatial boundary covers Center Hill Lake, Center Hill Dam, and the downstream tailwater (26.4 miles) to the confluence of the Cumberland River (mile 309) downstream to the Ohio River, but is actually regional in effect and not limited to the river itself. The temporal boundary covers the past 60 years, after impoundment of Center Hill Lake, to 10 years into the future, when dam repairs are complete. Factors influencing socioeconomics include recreation, hydropower, thermal power plant generation, water quantity, water quality, water supply, navigation, aquatic resources, including and property values. Socioeconomic activities include employment, personal income, tax base, local and regional spending on, and the cost of, goods and services. Historically Center Hill Lake has had an increasingly positive impact on local socioeconomics; however, lowering the lake is expected to have the opposite effect. A lower lake would negatively impact recreation, a large generator of local revenue and employment. Many jobs at the lake would be lost as fewer people visit the lake. Reduced visits would reduce the number of jobs supporting tourism as there would be less spending on lodging, eating, fuel, boats, boating, fishing, camping and swimming equipment. Lowering the lake would increase the cost of electricity, as hydropower generation is reduced or eliminated, and the quantity of cold water for thermal plants is reduced. A lower lake with reduced dissolved oxygen would impact tailwater water quality with the possible elimination of the profitable trout fishery, and potential harm to other aquatic life. Under these conditions, water treatment costs are likely to increase. A depressed local economy may reduce land values and property sales. This economic situation could continue through the 7 – 10 years of dam repairs. Other factors, such as drought and the repairs at Wolf Creek Dam, could compound the situation. The cumulative effect of the reduced water quantity in the Cumberland River system would affect navigation, resulting in delivery delays, lighter loading, and re-configuration of barges, resulting in lost revenue. In addition to mitigation measures previously mentioned, public relations might be used to monitor the situation and keep the public current of the actual local conditions.

5.0 List of Preparers

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Experience:	26 years Project Planning and Program Management
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	24 years Biologist, Project Planning Branch
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6.0 List Of Agencies, Organizations, And Persons To Whom Copies The Scoping Letter Was Sent

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Mr. Paul E. Davis, Director, TDEC NEPA Contact Division of Water Pollution Control 6th Floor L&C Annex 401 Church Street Nashville, TN 37243-1534	Mr. Reggie Reeves, Director, TDEC NEPA Contact Division of Natural Heritage and Scenic Rivers 7th Floor, L&C Annex 401 Church Steet Nashville, TN 37243-0447
Mr. Dan Eagar, NRS Manager TDEC - Division of Water Pollution Control 7th Floor L&C Annex 401 Church Street Nashville, TN 37243-1534	Mr. Robert D. Baker, Natural Resources Section TDEC - Division of Water Pollution Control 7th Floor, L & C Annex 401 Church Street Nashville, TN 37243-1534
Mr. Gregory M. Denton, PAS Manager TDEC - Division of Water Pollution Control 6th Floor L&C Annex 401 Church Street Nashville, TN 37243-1534	Ms. Sherry Wang, WMS Manager TDEC - Division of Water Pollution Control 6th Floor L&C Annex 401 Church Street Nashville, TN 37243-1534
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Mr. James W. Haynes, Director, TDEC NEPA Contact Division of Remediation 4th Floor, L&C Annex 401 Church Street Nashville, TN 37243-1538	Mr. Stan Boyd, Director, TDEC NEPA Contact Division of Underground Storage Tanks 4th Floor, L&C Tower 401 Church Street Nashville, TN 37243-1541
Mr. Mike Apple, Director, TDEC NEPA Contact Division of Solid and Hazardous Waste Management 5th Floor, L&C Tower 401 Church Street Nashville, TN 37243-1535	Mr. Lawrence E. Nanney, Director, TDEC NEPA Contact Division of Radiological Heath 3th Floor, L&C Annex 401 Church Street Nashville, TN 37243-0364

TDEC - Tennessee Commission of Indian Affairs 1st Floor, L & C Annex 401 Church Street Nashville, TN 37243-0435	Kevin Brown, State Conservationist USDA – Natural Resources Conservation Service 675 U.S. Courthouse 801 Broadway Nashville, TN 37203
Mr. James D. Slabaugh, State Soil Scientist USDA – Natural Resources Conservation Service 675 U.S. Courthouse 801 Broadway Nashville, TN 37203	Jenny Adkins, Water Quality Specialist USDA – Natural Resources Conservation Service 675 U.S. Courthouse 801 Broadway Nashville, TN 37203
Farm Services Agency Mr. David McDoyle, Executive Director 579 U.S. Courthouse Nashville, TN 37203	Honorable Susan Whitaker, Commissioner TN Department of Tourist Development 312 8th Avenue North, 25th Floor Nashville, TN 37243
Honorable Robert E. Cooper, Jr., Attorney General Office of the Attorney General and Reporter P.O. Box 20207 Nashville, TN 37202-0207	Honorable Barry Turner, Deputy Attorney General Office of the Attorney General and Reporter Environnemental Division P.O. Box 20207 Nashville, TN 37202-0207
Mr. Scott Gain, District Chief US Geological Survey 640 Grassmere Park Suite 100 Nashville, TN 37211	Honorable Harry A. Green, PhD, Executive Director TN Advisory Commission on Intergovernmental Relations 226 Capitol Blvd., Suite 508 Nashville, TN 37243
Mr. Ron Gatlin U. S. Army Corps of Engineers Regulatory Branch 3701 Bell Road Nashville, TN 37214	U.S. Army Corps of Engineers – Memphis District ATTN PLS: Regulatory Branch 167 North Main Street, B202 Memphis, TN 38103-1894
Gus L. Hargett, Adjutant General Department of Military P.O. Box 41502 Nashville, TN 37204-1502	James Bassham, Director Tennessee Emergency Management Agency 3041 Sidco Drive Nashville, TN 37204
Honorable David Mitchell, Commissioner Office of Homeland Security William R. Snodgrass, TN Tower, 25th Floor Nashville, TN 37243	Honorable Phil Bredesen, Governor Governor's Office Tennessee State Capitol Nashville, TN 37243-0001

Honorable Gerald F. Nicely, Commissioner Tennessee Department of Transportation James K. Polk Building, Suite 700 505 Deaderick Street Nashville, TN 34243-0349	Honorable Alan Jones TDOT - Environmental Planning and Permits Division James K. Polk Building, Suite 900 505 Deaderick Street Nashville, TN 37243-0334
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John Fisher, Transportation Manager II TDOT – Office of Rail & Water Transportation James K. Polk Bldg., Suite 1800 Nashville, TN 37243	Honorable Leslie A. Newman, Commissioner TN Department of Commerce & Insurance 500 James Robertson Parkway Davy Crockett Tower Nashville, TN 37243-0565
Mr. David Stuki, Manager Aquaity Biology Section Laboratory Services 630 Hart Lane Nashville, TN 37247	Honorable Susan Cooper, Commissioner Tennessee Department of Health 425 Fifth Avenue, North Cordell Hull Building, 3rd Floor Nashville, TN 37247
Honorable Matt Kisber, Commisioner TN Department of Economic & Community Development 312 8th Avenue North, 11th Floor Nashville TN 37243-0405	Mr. Michael Atchison, Director, NEPA Contact TN Department of Economic & Community Development 312 8th Avenue North, 11th Floor Nashville TN 37243-0405
Honorable Ken Givens, Commissioner Tennessee Department of Agriculture Ellington Agricultural Center, Melrose Station Box 40627 Nashville, TN 37204	Honorable John McClurkan, Administrator TDA – Water Resources Section/Nonpoint Source Ellington Agricultural Center - Holeman Building P.O. Box 40627, Melrose Station Nashville, TN 37204
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7.0 Index

APPENDIX A

BIOLOGICAL ASSESSEMENT

Center Hill Lake and Dam
DeKalb County, Tennessee

US Army Corps of Engineers

Nashville District

CENTER HILL LAKE AND DAM
DEKALB COUNTY, TENNESSEE

CHANGES TO OPERATIONAL GUIDE CURVES POOL ELEVATIONS

BIOLOGICAL ASSESSMENT

US Army Corps of Engineers

November 2007

Center Hill Lake and Dam
Changes To Operational Guide Curves Pool
Biological Assessment

TABLE OF CONTENTS

1.0. Introduction

The Corps of Engineers, Nashville District, is preparing a Draft Environmental Impact Statement (DEIS) to address proposed operational changes at Center Hill Dam that could affect pool elevations in Center Hill Lake. Center Hill Dam is located in DeKalb County in central Tennessee.

Center Hill Dam, impounded in the early 1950s, was built on karst geology using accepted engineering practices of the day. Since the 1960s, seepage flows through the dam's right abutment and left rim wall have been monitored. Repairs have been made at various times and include grout injection into the dam foundation, earthen embankment, right abutment and left rim. These repairs were effective; however recent increased seepage and development of turbid flows through springs below the left rim wall have become concerns. A comprehensive plan to repair the dam was approved, but will take a number of years to complete. The plan includes a major grouting project scheduled to start in fall 2007, to address the dam seepage, followed by installation of a cutoff wall through the main dam and saddle dam. These repairs along with other alternatives were discussed in the following NEPA documents: *Proposed Center Hill Dam Seepage Rehabilitation, Environmental Assessment, July 2005*; and *Proposed Center Hill Dam Seepage Rehabilitation, Environmental Assessment Supplement 1, March 2006.* A Finding of No Significant Impact (FONSI) was signed for each of these documents.

Since March 2005, the Corps has attempted to keep fall, winter and early spring lake levels from extreme rises due to high inflow. Seepage problems are made worse during continual high lake levels. Until repairs are sufficiently complete, the Corps has determined that it is in the public's interest to operate Center Hill Lake at the lower range of the operations guide curve to reduce pressure on the dam foundation, abutments, and rim walls. A formal risk assessment is expected to recommend that the lake level be dropped and maintained year round in a band between elevation 618 and elevation 625 until the foundation's integrity is restored.

This Biological Assessment (BA) is necessary to provide a basis for informal or formal (if required) Section 7 Consultation and for National Environmental Policy Act (NEPA) compliance to address impacts that could occur due to possible changes in lake levels

1.1. Purpose Statement

The primary objective of this informal Section 7 consultation process is to determine if lowering the lake levels below the normal guide curves at Center Hill Lake may adversely affect federally listed species or designated critical habitat. If so, the Corps Nashville District will enter formal consultation, and the USFWS will develop reasonable and prudent measures and incidental take terms and conditions while required repairs are effected.

1.2. Scope

The Corps of Engineers Nashville District is committed to full compliance with the Endangered Species Act regarding its operations and maintenance activities on the Cumberland River. Because the lower pool elevations have the potential to affect TVA operations at two fossil fuel power plants and affect the lake levels and navigation in Kentucky Lake via the Lake Barkley/Kentucky Lake canal, the Corps has requested that TVA serve as a cooperating agency for the EIS. The geographical areas to be addressed in this Biological Assessment and informal Section 7 consultation process consist of the Cumberland River from its mouth through Barkley, Cheatham, and Old Hickory lakes, the Caney Fork River between Center Hill Dam and its confluence with Old Hickory Lake, Center Hill Lake, and Kentucky Lake and its tailwaters on the Tennessee River. Paragraph 3.1 and Table 1 below further define the action area and multi-purpose projects within the study areas of the Tennessee and Cumberland River systems. The table also provides Internet links to the Navigation Charts (river mapping) for those rivers and projects. This Biological Assessment examines impacts of the possible lowered operating levels associated with Dam repairs to determine whether any are likely to adversely affect federally listed species or designated critical habitat. This process does not consider the effects of construction which was covered under previous NEPA assessments.

1.3. Previous NEPA Documents, Section 7 Consultations, and Studies.

Final Environmental Impact Statements for open channel maintenance of the Tennessee River and tributaries and for operation, maintenance and management of water resource projects on the commercially navigable portion of the Cumberland River were filed in March 1976 and November 1975, respectively. Both were prepared as composite or “umbrella” statements as defined in Corps implementing regulations at the time (ER 1105-2-507). Both statements followed fairly closely the enactment of the Endangered Species Act, and clear implementation procedures for Section 7 of the Act had not been established. Also many species had not yet been federally listed. Endangered Species Act compliance was not raised as an issue in the agency review comments. These “umbrella” statements were followed-up by site specific NEPA Documents as each substantial specific operation and maintenance action was proposed. Section 7 compliance was completed for each individual action, when appropriate, within the respective individual NEPA processes and under the consultation regulations in effect at the time.

In July, 2007 the Corps submitted a BA titled, *Biological Assessment Operation and Maintenance of the Tennessee and Cumberland Rivers Navigation Systems*, to determine if any Corps of Engineers operation and maintenance activities associated with navigation along the Tennessee/Cumberland Rivers adversely affect federally listed species or designated critical habitat. A list of previous NEPA Documents and/or Section 7 consultations and studies related to the Tennessee and Cumberland Navigation Systems is provided in Appendix B.

Numerous reports and studies have been completed at Center Hill Dam and Lake and are cited in the document titled, *Center Hill Dam, DeKalb County, Tennessee, Seepage Control, Major Rehabilitation Evaluation Final Report, LRD Review, 14 July 2006*. These documents include Center Hill Dam and Lake Master Plans, O&M Plans, Continued Operation, Maintenance, and Management EA, design plans, security plans, spill plans, and more. An Environmental Assessment (EA) was completed for remediation of the left and right rim and a Finding of No Significant Impact was signed. During the study process, additional alternatives were identified for the main dam embankment and saddle dam and a Supplemental EA was completed and a FONSI. Rehabilitation alternatives considered, potential impacts analyzed, and public and agency comments considered were included in the two EAs. They were titled, *Proposed Center Hill Dam Seepage Rehabilitation, Environmental Assessment, July 2005*; and *Proposed Center Hill Dam Seepage Rehabilitation, Environmental Assessment Supplement 1, March 2006.*

2.0. Description of the Tennessee and Cumberland River Systems

2.1. History and Authority

The River and Harbor Act of 3 July 1832 authorized the first open-channel work on the Cumberland River (U.S. Army Corps of Engineers, Nashville District. 1975). Since then, the Corps of Engineers, Nashville District has been responsible for planning, construction, operation, maintenance and management of facilities, waters, and lands associated with water resource development projects in the Cumberland River Watershed.

In the early part of the 20th century, major floods occurred in the Ohio and Mississippi River basins, which resulted in disastrous losses of lives, property, and economic stability. Ensuing public outcry for government agencies to take protective measures led to the development in 1937 of a comprehensive flood control plan by the U.S. Army Corps of Engineers (Corps). The comprehensive plan proposed construction of 45 flood control reservoirs in the Ohio River basin. Six flood control reservoirs were recommended for the Cumberland River Basin, of which four were eventually built. These four are Wolf Creek (Lake Cumberland), Dale Hollow, Center Hill, and J. Percy Priest Dams.

The Flood Control Act of 1938 authorized dam construction for Center Hill Dam. Supplementing authorizations were the Third Supplemental Defense Act of 1941, the Flood Control Act of 1944, and the River and Harbor Act of 1946. Section 4 of the Flood Control Act of 1944 authorized the Chief of Engineers to construct, maintain, and operate public park and recreational facilities and to permit construction, maintenance and operation of such facilities. The Federal Water Project Recreation Act of 1965 established development of the recreational potential at federal water resource projects as a full project purpose. The Fish and Wildlife Coordination Act (16 USC 661) and the Fish and Wildlife Conservation Act of 1980 (16 USC §§ 2901 – 2911) recognized "…the vital contribution of our wildlife resources to the Nation…" and provided that "…wildlife conservation shall receive equal consideration and be coordinated with other features of water-resource development programs…" The Clean Water Act (33 U.S.C. 1252 § 102(b)) added water quality to the Corps' mission at water-resource development projects. The River and Harbor Act of 1958 (43 U.S.C. 390b), authorizes the Secretary of the Army to include municipal and industrial water storage in Corps projects and to reallocate storage in existing projects to municipal and industrial water supply.

As a result of these legislative actions, the currently authorized project purposes for the Center Hill Lake Project are flood control, hydropower generation, recreation, fish and wildlife management, water quality, and municipal water supply. Although not specifically authorized for the purpose, Center Hill Dam also makes some contribution to navigation as a by-product of its releases, particularly on the lower Ohio and Mississippi Rivers.

2.2. Description of Reservoirs

The Corps of Engineers constructed, operates, and maintains ten dams in the Cumberland River Basin. All of the dams are operated as multiple-use projects, although not all dams can support all uses. The "mainstem" dams, Barkley, Cheatham, Old Hickory, and Cordell Hull were all authorized and designed for navigation and have locks associated with the dams. The other six dams, including Wolf Creek Dam, are considered "tributary" dams. All of the dams and reservoirs are, of necessity, operated as a single system. The vast majority of the water that passes through the mainstem lakes originates at one of three large reservoirs, Lake Cumberland (Wolf Creek Dam), Dale Hollow, and Center Hill. In a typical year, Lake Cumberland supplies about 60% of the water in the Cumberland River, with Dale Hollow and Center Hill each supplying between 15% and 18%. How these reservoirs are operated, and the timing and volume of their releases is, therefore, of great concern for all of the downstream resources.

Center Hill Dam is a large, high head dam located near Lancaster, Tennessee at Caney Fork River Mile 26.6 (Figure 1). It was originally designed for flood control and hydropower generation. Subsequent authorizations added water quality, recreation, fish and wildlife management, and water supply to the project purposes. The average discharge below the dam is 3,800 cubic feet per second. The maximum lake depth is 173 feet and the lake retention time is 131 days. The length of the pool at elevation 685 is 64 miles. The length, depth, and retention time have combined to alter the lake and particularly the tailwater from a warm-water fishery to a cold-water fishery. The tailwater of Center Hill Dam flows into the upper end of Old Hickory Lake at Carthage, Tennessee. The Center Hill Lake and the Caney Fork River contribute about 15% to 18% of the total flow of the Cumberland River below Cordell Hull Dam. Center Hill typically has a winter pool elevation of 623. Under normal conditions, late winter and spring rains are captured and retained to reduce flooding downstream and to store the water for later use. Usually Center Hill is allowed to fill to elevation 648 by the Fourth of July. This is done in part for recreational enhancement, but primarily to allow peaking hydropower generation during the summer when power demands are greatest and to supply fresh water to sustain water quality in the mainstem lakes. From about the

Fourth of July on Center Hill Lake is slowly drained until the winter lake levels are reached and the cycle begins once again.

Old Hickory Lock and Dam, located on the Cumberland River at mile 216.2 in Sumner and Davidson Counties, Tennessee, is approximately 25 miles upstream from Nashville, Tennessee. The lake extends 97.3 miles upstream to Cordell Hull Lock and Dam near Carthage, Tennessee. Old Hickory Lock and Dam was authorized for construction by the Rivers and Harbors Act of 1946 as a unit of a comprehensive development plan for the Cumberland River Basin and is a mainstream storage impoundment on the Cumberland River. Its primary authorization was for navigation and hydropower production. Other authorized project purposes now include recreation, water quality, municipal and residential water supply, and fish and wildlife management. Old Hickory has no flood storage capacity and its water level fluctuations are minimal. Its tailwaters flow into Cheatham Lake.

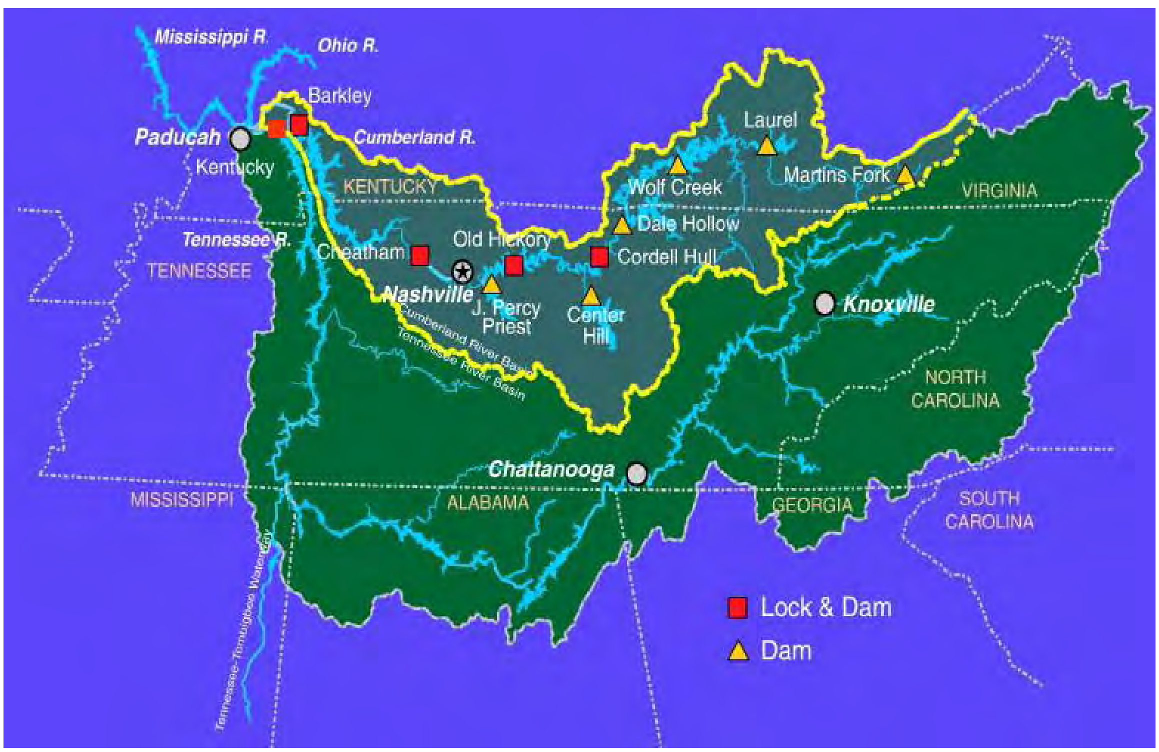

Figure 1

Congress authorized the Cheatham Lock and Dam Project in 1946 as a navigation unit of a comprehensive plan of development for the Cumberland River Basin. The original purpose of this water resources development project was to replace three smaller, aging locks built at the turn of the century. In 1952, Congress added authorization for the production of hydroelectric power as a project function. The lake is a “run-of-the-river” type that operates basically on normal streamflow. The Corps uses as much of the inflow as practicable for hydropower generation. The dam was not constructed to provide a designated capacity for regulating floodwaters. Therefore, during periods of heavy rainfall and high streamflow, the spillway gates are opened to pass waters in excess of the capacity of hydropower turbines. Cheatham Lock and Dam backs water for 67.5 miles to Old Hickory Lock and Dam. Other authorized project purposes now include recreation, water quality, municipal and residential water supply, and fish and wildlife management. Cheatham's tailwaters flow into Lake Barkley.

Lake Barkley is a multi-purpose project designed for flood control, navigation, and hydropower. Other authorized project purposes now include recreation, water quality, municipal and residential water supply, and fish and wildlife management. Located at Cumberland River Mile (CRM) 30.6, Barkley Lock and Dam on the lower Cumberland River functions as an auxiliary lock for the Kentucky Lock since the Barkley Lock is accessible to Tennessee River traffic through the Barkley Canal. Two additional purposes for which Lake Barkley is managed are recreation and fish and wildlife. It has a 118.1 backwater which ends at Cheatham Lake. Below Barkley Lock and Dam the Cumberland River flows to its confluence with the lower Ohio River. The tailwater is greatly influenced by backwater from Lock and Dam 52 and the discharges from Smithland Lock and Dam on the Ohio River.

Kentucky Lake is on the Tennessee River, but is connected to Lake Barkley by a 1.5-mile long unregulated canal that connects the Tennessee and Cumberland Navigation Systems. The Nashville District operates and maintains the locks at this project, while TVA operates and maintains the associated dam, pool, and hydropower facilities. It is because of the connection through the canal that Kentucky Lake is included in this BA. Kentucky Lock and Dam are located at Tennessee River Mile (TRM) 22.4. Kentucky Lock and Dam (TRM 22.4) backs up water for 184 miles to Pickwick Lock and Dam.

Cordell Hull is not a concern for this BA, but delineates the upstream boundaries of effects. As previously mentioned, Barkley Lock and Dam also has a collateral function as an auxiliary lock for Kentucky Lock since it is accessible to Tennessee River traffic through the Barkley Canal. The Nashville District has primary responsibility for operation, maintenance, and management of the multi-purpose projects including hydropower, flood control, water supply, fish and wildlife, navigation, and recreation. In addition to operating, maintaining and managing the four lock and dam projects and Center Hill, the Nashville District is responsible for operating and maintaining five other tributary projects. These are J. Percy Priest, Dale Hollow, Cumberland, Laurel River, and Martins Fork Lakes. None of these is of direct concern for this BA although their flows do influence the cumulative impacts.

The Cumberland River is considered a very scenic river with numerous historic locations along the shoreline. It draws many of the same large inland cruise ships each year that run the Tennessee River. The major difference is they only travel 190 miles up the Cumberland to Nashville, Tennessee. Commercial traffic is comprised primarily of barges loaded with commodities and raw materials. Tows traveling the Cumberland River typically consist of nine to twelve barges. Each year approximately 23.0 million tons of commodities are transported on the Cumberland River. Commodities most often shipped on the Cumberland parallel those seen on the Tennessee River.

2.3. General Environmental and Socioeconomic Setting of the Region

Although dated, the “umbrella” environmental impact statements referenced in Paragraph 1.3 above included the most comprehensive description of the environmental and socioeconomic setting of the twin navigation systems available at the time and until the turn of the 21st century. The Programmatic Environmental Impact Statement for the Tennessee Valley Authority Reservoir Operations Study provides a contemporary description of the Tennessee River Valley setting, although coverage is much broader than the navigable portion of the Tennessee River. There is no contemporary comprehensive description of the Cumberland River System, although limited individual project NEPA documents and resource assessments provide localized descriptions of the setting along the river corridor.

2.3.1. Cumberland River System

The Cumberland River is formed by the confluence of the Poor and Clover Forks of the Cumberland River near Harlan, Kentucky some 692.8 miles above its mouth at the Ohio River at Smithland, KY. With a drainage area of 17, 598 square miles and navigable length of 381.0 miles, the Cumberland River could in many ways be considered a scaled-down twin of the Tennessee River. The river flows through three Physiographic Regions; the Highland Rim, Central Basin and Pennyroyal Plateau Regions. The Cumberland River Watershed is characterized by Karst topography. Within the navigable length of the river, the slope averages a low to moderate 0.52 feet per mile, more gradual than the slope of the Tennessee River. The majority of the navigable portion of the river meets both state and federal water quality criteria and guidelines, except the lower portion (Livingston Co., KY) which is affected by the presence of pathogens from septic tanks, municipal sewage treatment plants, sewer overflow, land disposal, and agriculture.

As previously mentioned, the Tennessee-Cumberland River ecoregions have the highest number of fish, crayfish mussels and endemic species in North America; however, the greatest diversity in the Cumberland System is upstream of the navigation system, i.e., beyond the scope of this BA. The water quality and physical environment of the Cumberland River were significantly altered with the construction of the reservoir system when free-flowing river habitat was converted to reservoir pools. A higher proportion of the Cumberland Navigation System retains riverine characteristics in comparison with the Tennessee, but the river flows slower because of the low to moderate gradient. In addition to the conversion from riverine habitat to reservoir pools, a cold water fishery developed in the upper portion of the navigation system due to the discharge of Wolf Creek, Center Hill, and Dale Hollow dams as well as construction of the relatively deep Cordell Hull Reservoir. As a result, a combination of lotic, lentic, warm and cold water species inhabit the navigable portion of the Cumberland River, with the majority of the fishery being warm water. The mussels of the navigable Cumberland River are characterized by relatively poor quality shells, and have little commercial demand. As a result, little emphasis has been placed on their study, and most available data is related to proposals such as maintenance dredging. There are, however, viable sport and commercial fisheries with the sport fishery notably flourishing from Cordell Hull Dam downstream.

There are three major forest types in the Cumberland River Watershed; Bottomland Hardwood, Western Mesophytic, and Cedar Glade. Of these, the Bottomland Hardwood and Western Mesophytic types generally characterize the study area. A mosaic of forest and agricultural lands with corresponding wildlife diversity dominate the lands surrounding the system, except in the larger population centers of Clarksville – Montgomery County, Tennessee and the Nashville – Davidson, Tennessee SMSA (Standard Metropolitan Statistical Area). The population centers along the river are rapidly growing, and the primary threats to terrestrial plant and animal communities are loss of habitat to human development and introduction of exotic invasive species. Based on informal observation, residential development is the most prevalent developed land use around the system, although two major recreational marinas are proposed in the Nashville area.

Social and economic resources in the Cumberland River Valley Region have generally grown since 1990. The population has grown at a greater rate than the overall state rate for the more rural counties and at a lesser rate for Metropolitan Nashville – Davidson County, reflecting a trend away from that large population center. Since 1990, employment has increased throughout the study area, with unemployment remaining in the single digits, ranging from 3.4% to 8.7% (for Stewart County, TN, which has traditionally had a depressed economy). The region has a high percentage of its workers employed in the service, goods-producing, and construction sectors and a lower share of its workers in the mining, farming/fishing/ forestry and government sectors. Navigation, along with power supply, water supply, transportation corridors and other factors, is considered a direct economic driver for the region.

2.3.2. Tennessee River System

The Tennessee River is formed by the confluence of the French Broad and Holston Rivers at Tennessee River Mile 652.0 and drains approximately 41,000 square miles in seven states. The only portion of the river that this BA is concerned with is between the mouth of the river at its confluence with the Ohio River, through Kentucky Lock and Dam up to Pickwick Lock and Dam. This portion of the Tennessee River flows through two physiographic regions, the Southeastern Plains and the Interior Plateau in portions of Tennessee, Mississippi, and Kentucky. The area is characterized by Karst topography. The average slope of the navigable portion of the river is gradual at 0.77 feet per mile (Tennessee Valley Authority, 2004). The Kentucky Lake is highly regulated, with free flowing reaches only in the Pickwick tailwater[1]. The relatively heavy

[1] a stream segment downstream of a dam, in which the discharge and resulting flows create river-like conditions similar to those of an unimpounded stream.

annual rainfall of 50 – 60 inches is concentrated in the cool months of the year, with March usually being the wettest month. Average annual temperature ranges from 56.3 degrees F to 60.1 degrees F, depending on location within the valley. July and August are the warmest months, and January is the coolest. Current air quality meets the National Ambient Air Quality Standards (NAAQS). Kentucky Lake and tailwater meet both state and federal water quality criteria and guidelines.

The Tennessee-Cumberland River ecoregions have the highest number of fish, crayfish mussels and endemic species in North America, and the Tennessee is the most diverse temperate freshwater ecosystem in the world (Tennessee Valley Authority, 2004). With the construction of the TVA and Corps reservoir systems both the water quality and physical environment of the rivers were significantly altered. The reservoir system's primary impact was to convert free-flowing river habitat to reservoir pools. Many riverine[2] species, especially mollusks, minnows and darters, could not adapt to the switch in environments and were extirpated from their former habitats. For a number of species that were not extirpated, the habitat alterations affected their abundance so that they became rare and are listed as state or federal threatened or endangered species. Some riverine species continue to live in remnant habitats that mimic riverine conditions, while other species that thrive in impoundments have increased in abundance and expanded their ranges. For example, freshwater mussels adapted to riverine conditions are the largest category of threatened or endangered species in the system and are doing poorly, while mussels that are adapted to pool; conditions are doing well. The best surviving riverine mussel communities are in the tailwaters, defined as the flowing mainstem river reaches below dams, but their status there is still only fair. Recent efforts have improved tailwater habitats, and state and federal agencies are reintroducing experimental populations of rare native species to some tailwater areas. On the other hand, there are thriving commercial and sport fisheries in the system, based on species of fish and mussels that are well adapted to impounded waters.

3.0 Approach and Process

This assessment was begun as a part of a study of the potential impacts of possible need to lower Center Hill Lake until foundation and structural problems with the dam can be rectified. The principle concern was that the study should strike the appropriate balance between scientific rigor and responsible fiscal practice. To reach the proper scope for the study, it was decided to apply a sensitivity test in the broadest possible sense (i.e. determine whether the prolonged lowering of the Center Hill Lake pool would have any influence on an activity or an area). Starting, then, with the broadest possible scope for the action area, activities and species, the scope was then narrowed, based on scientifically valid reasoning, until it reached a focus on the relevant action area, activities and species. All three elements of the BA – the action area, activities list, and species list – were considered as starting points, to be amended should additional information become available during preparation of the BA.

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[2] related to, or resembling a river.

3.1 Defining the Action Area

Definition of the action area was determined to be Center Hill Lake itself and all of the downstream waterways affected by the Center Hill waters, to their confluence with the Ohio River. This includes Old Hickory Lake, Cheatham Lake, Lake Barkley, and the Barkley tailwater. Kentucky Lake and its tailwater were also included due to its connection with the Cumberland River in Lake Barkley via an unregulated navigation channel and it is included when discussing the mainstem lakes. To ensure that all species of concern were included, the U.S. Fish and Wildlife Service and the state's natural heritage agencies were contacted and all federally threatened or endangered species listed in any county adjoining the waterways were included. Each species was then considered individually with regard to whether or not a prolonged lowering of Center Hill Lake would impact the species. Upstream and tributary projects on the Cumberland and Tennessee River Systems were quickly eliminated from the action area because they are not affected by the operations of Center Hill Lake and Dam (i.e. water is already coming through the dams for other purposes, and the "but for" test is not met.). TVA may release waters from its Tennessee River system above Pickwick Lock and Dam, but TVA's activities are outside the scope of this BA. Table 1 delineates these waters. Landward boundaries of reservations and facilities that meet the "but for" test are included in the action area and the full terrestrial extent of the action area is "case-by-case" based on the species and the impact area of each specific activity.


Cumberland River
Laurel
Martins Fork
Wolf Creek
Cordell Hull
Carthage
Celina
Dale Hollow
Old Hickory
Center Hill
Clarksville
Nashville
Cheatham
J. Percy Priest
Barkley
Ohio River
Smithland
Mississippi River

Figure 2

Table 1

Study Areas
Tennessee and Cumberland River Systems by River Mile

WATER COURSE	MILE (Start)	MILE (End)	Navigation Chart Reference
Cumberland River	**0.0**	**389.0**	http://www.lrn.usace.army.mil/opn/CumbRiver/ (Use this Internet link for waterways listed below.)
River below Lake Barkley	**0.0**	**30.6**	
Lake Barkley	**30.6**	**148.6**	
Lower Barkley	30.6	102.3	
Barkley Canal	0.0	1.5	
Hammonds Creek	0.0	1.7	
Lick Creek	0.0	6.4	
Eddy Creek	0.0	7.0	
Little River	0.0	18.0	
Upper Barkley	102.3	148.6	
Red River	0.0	10.8	
Cheatham Lake	**148.7**	**216.1**	
Lower Cheatham	148.7	166.0	
Harpeth River	0.0	10.3	
Upper Cheatham	166.0	216.1	
Old Hickory Lake	***216.2***	***313.4***	
Lower Old Hickory	216.2	265.0	
Drakes Creek	0.0	4.0	
Spencer Creek	0.0	11.0	
Station Camp Creek	0.0	3.0	
Bledsoe Creek	0.0	4.8	
Barton Creek	0.0	6.7	
Spring Creek	0.0	6.8	
Upper Old Hickory	265.0	313.4	
Caney Fork River below Center Hill Lake	0.0	26.6	
Center Hill Lake	26.6	90.6	

Table 1 Continued

Tennessee River	**0.0**	**652.0**	http://www.lrn.usace.army.mil/opn/TNRiver/ (Use this Internet link for waterways listed below.)
River below Kentucky Lake	**0.0**	**22.4**	
Kentucky Lake	**22.4**	**206.7**	
Lower Kentucky Lake	22.4	145.0	
Jonathon Creek	0.0	6.3	
Blood River	0.0	8.8	
Big Sandy River	0.0	15.0	
Duck River	0.0	19.4	
Beech River	0.0	15.0	
Upper Kentucky Lake	145.0	206.7	

3.2 Listing and Definition of Activities

Reservoir releases are defined as discharge of water through a hydroelectric plant or spillway gates. On the Cumberland and Tennessee Rivers the most frequent purposes of reservoir releases are for hydropower production or creation/maintenance of flood storage capacity. Under drought or emergency conditions (such as a grounded vessel) a reservoir release may be rarely used to provide minimum navigation depth. Although this has been done on the Tennessee and other rivers there is no record of increased flows having been used for this purpose on the Cumberland River. As noted above, the Nashville District has primary responsibility for operation, maintenance, and management of the multi-purpose projects for the purposes of hydropower, flood control, water supply, fish and wildlife, navigation, and recreation although not all lakes are operated to fulfill all of these functions. For example, Center Hill Lake is operated for hydropower, flood control, water supply, fish and wildlife, and recreation, but is not directly concerned with navigation, although water released from Center Hill does incidentally contribute to the water used for navigation. The lakes are necessarily operated as a single system. Below Cordell Hull Lock and Dam, Center Hill and the Caney Fork supply between 15% and 18% of the water in the Cumberland during the course of a normal year.

Working through each of the project purposes, i.e., navigation, hydropower, flood damage reduction, water supply, fish and wildlife management, and recreation, we can draw the following conclusions.

As previously noted, Center Hill has no direct authority to support navigation. The impacts of navigation on threatened or endangered species has been thoroughly covered in the *Biological Assessment Operation and Maintenance of the Tennessee and Cumberland Rivers Navigation Systems.* The mainstem lakes are always maintained at certain lake levels to ensure adequate depths for navigation. As a result they show relatively little fluctuation. Although Center Hill's releases make some contribution to navigation as a by-product of its releases, particularly on the lower Ohio and Mississippi Rivers, lowering the Center Hill pool would not have a direct impact on navigation, nor would it cause an appreciable change in the pool levels of any of the mainstem lakes. Navigation is not, therefore, a consideration for this BA.

Center Hill Lake has two municipal water intakes and one intake for a golf course. The intakes are located deep within the lake below the bottom of the power pool. It is estimated that 75 to 80 percent of the water withdrawn is eventually returned to the Cumberland River system. Water allocated for water supplies is considered to be low in the lake and the volumes withdrawn have little impact on the overall lake levels. Municipal and industrial water withdrawals are relatively small in comparison to the volume of the system and are replaced in any case by the lakes maintaining navigation depths. Municipal water supply, therefore, is not a consideration for this BA.

All of the lakes are operated with recreation in mind. Barkley and Kentucky Lakes enjoy increased water depths (about a five foot increase) during the summer months to enhance recreational activities. Center Hill differs from the mainstem lakes in that it was designed for flood damage reduction and hydropower generation. It typically has a winter pool elevation of 623. Late winter and spring rains are captured and retained to reduce flooding downstream and to store the water for later use. Usually Center Hill is allowed to fill to elevation 648 by the Fourth of July. This is done in part with recreational enhancement in mind, but primarily to allow peaking hydropower generation during the summer when power demands are greatest and to supply fresh water to sustain water quality in the mainstem lakes. Recreation is not the determining factor in establishing Center Hill's elevations and, therefore, has little direct effect on any species of concern. Recreation, therefore, is not a consideration for this BA.

Center Hill was designed and is operated for flood damage reduction. Typically flood waters are captured and retained in Center Hill until they can be released safely downstream. This has little or no impact on the species in question although it may occasionally benefit some of them as it reduces particularly violent scouring of the streambed and banks. If Center Hill must operate at lowered levels or on a flat-line regime while the dam is repaired, then whatever water flows into the lake will be immediately released. This will essentially mimic what would have been the natural flow had the dam never been built and should not unduly impact any species of concern. Flood damage reduction is not, therefore, a consideration for this BA.

Center Hill was designed and is operated for hydropower production. It produces hydropower from stored water in the lake and hydropower is the preferred method for regulating the lake level. The power pool is between elevations 618 and 648. Water from Center Hill's generation is also used by the mainstem lakes to produce power. Hydropower generation has caused fish and wildlife losses in the past by scouring the river beds with pulsed flows and then suddenly cutting off flows. However, hydropower production is not the primary cause of the overall losses. It is anticipated that if a reduced lake level or flat-line regime is adopted while repairs on the dam are effected, hydropower will continue to be the primary method of maintaining the levels. Reducing the lake level in Center Hill would not affect the impacts of the hydropower generation by the mainstem lakes, except possibly the timing of their releases. That is, the same volume of water would be passed to the mainstem lakes for their uses, but rather than retaining it for release during the summer when flows are typically lower, the releases would be made immediately as the water flowed into Center Hill Lake, mainly during the late winter and spring months. Hydropower, therefore, is not a consideration for this BA.

Water quality is a complex and difficult problem at Corps lakes. Although the dams themselves do not cause pollution, they do contribute to the problems. The Center Hill Lake is much deeper than the original Caney Fork River. The riverine ecology above the dam was drowned out and converted to a lacustrian ecology. Unable to move, mussels that once existed there were extirpated. The long retention time of Center Hill has greatly reduced the water temperatures. In the tailwater below Center Hill the warm water fishery was forced out by the new cold water regime to the extent that the Caney Fork has been classified as a trout stream. Nutrients entering the lake are held long enough for bacterial action to virtually eliminate dissolved oxygen (DO) at certain times of the year. Mussels in the Caney Fork tailwater are too cold to successfully reproduce and their host fish may no longer present in any case. It is believed that the original native mussel population has been extirpated from the Caney Fork. Hydropower discharges during the summer months had very low DO and in recent years the Corps has been experimenting with discharging water through the sluice gates to provide both minimum flow and adequate DO. If Center Hill is operated at a reduced level or flat-line regime, there will be less cold water storage. Water releases may be warmer than experienced under the current operating guide curves. There would also be less water available during the summer months for mitigating water quality issues in the mainstem lakes. Lower flows in the mainstem lakes would translate to longer retention times, which, in turn, usually result in decreased water quality and increased stress on aquatic organisms. As Center Hill only contributes about 15% of the total water in the Cumberland River, the reduction in water quality and increase in stress to aquatics caused by changes in Center Hills operations would be minor.

Center Hill and the mainstem lakes are operated with fish and wildlife in mind. Examples include trying to maintain level pools during fish spawning periods, committing to minimum flow releases, and discharging water through the sluice gates to maintain adequate oxygen levels in the tailwaters. Whenever another authorized project purpose has the potential to negatively impact fish or wildlife resources, every effort is made to avoid or mitigate the impacts.

Working under the concept of focusing down from the broadest possible scope, a list was compiled of all authorized project purposes potentially meeting the sensitivity test as they relate to the water passing through and released by Center Hill Dam. As can be seen from the discussion above, the only significant impact Center Hill can have on endangered species is through its impact on water quality and the methods chosen to manage and mitigate for fish and wildlife

3.3 Screening of Activities and Species

Working from the national U.S. Fish and Wildlife Service website, a complete list was compiled of all Federally listed species recorded in the counties that include or touch the Kentucky, Barkley, Cheatham, Old Hickory, and Center Hill Lakes, and the lower Tennessee and Cumberland Rivers below Kentucky and Barkley Lakes This consisted of 47 species. Then, working from the Cookeville updated list, 3 species of mussels and 1 species of fish were dropped from consideration because they are no longer listed for the above counties. Working from the Frankfort Ecological Services Office list 1 species of fish and I species of bird were also dropped from consideration for the same reason. Additionally, 2 species of mussels from the national website were dropped from consideration because they are listed only from historic (pre- 1970) records in the above counties and are considered extirpated in the study area. Finally, 3 mussel species appearing on the Cookeville list, but not on the national website for the above counties were not considered because they also are listed only from historic (pre- 1970) records and are considered extirpated in the study area. This screening resulted in 36 species receiving detailed consideration in this Biological Assessment (see Table 2.). Then the activities and species were each assessed on a case-by-case basis to determine if changes to water quality caused by the lowering of Center Hill's pool could affect that species. The results of this assessment were then plotted in a matrix (see Table 3). Working through the remaining list, twenty-nine species that would not be affected by changes resulting from altering Center Hill's lake level (for example glade species such as Stones River bladderpod or species found only in upper Kentucky Lake) were noted as "No Effect". The remaining 7 species which were determined to potentially be disturbed were noted as "May Affect.

4.0 Individual Activity/Species Impacts

The following is an assessment of possible impacts of implementing reduced lake levels or a flat-line regime on Center Hill Lake on each species selected for evaluation, in light of best available information and professional judgment. Each discussion begins with a summary of the species account for the species under consideration.

Scientific Name	Common Name	Status	Class	County
Alosa alabamae	Alabama Shad	C	Actinopterygii	Not listed in study area – Eliminated from detailed consideration.
Apios priceana	Price's Potato-bean	LT	Magnoliopsida	Stewart, Montgomery, Davidson, Wayne, DeKalb
Arabis perstellata	Braun's Rockcress	LE	Magnoliopsida	Davidson, Wilson
Astragalus bibullatus	Pyne's Ground-plum	LE	Magnoliopsida	Davidson
Charadrius melodus	Piping Plover	LE	Aves	CALLOWAY, MARSHALL
Conradina verticillata	Cumberland Rosemary	LT	Magnoliopsida	White
Cumberlandia monodonta	Spectaclecase	C	Bivalvia	Smith
Cyprogenia stegaria	Fanshell	LE	Bivalvia	MARSHALL, Hardin, Decatur
Dalea foliosa	Leafy Prairie-clover	LE	Magnoliopsida	Davidson, Wilson, Sumner
Dromus dromas	Dromedary Pearlymussel	LE	Bivalvia	Davidson*,Trousdale, DeKalb*, Smith
Echinacea tennesseensis	Tennessee Coneflower	LE	Magnoliopsida	Davidson, Wilson
Epioblasma brevidens	Cumberlandian Combshell	LE	Bivalvia	Davidson*, Smith, Trousdale*, Wilson
Epioblasma capsaeformis	Oyster Mussel	LE	Bivalvia	Not in study area – Eliminated from detailed consideration..
Epioblasma florentina florentina	Yellow-blossom pearly mussel	LE	Bivalvia	Smith* - Historic. Eliminated from detailed consideration.
Epioblasma florentina walkeri	Tan Riffleshell	LE	Bivalvia	Davidson*, Perry* - Historic. Eliminated from detailed consideration.
Epioblasma obliquata obliquata	Catspaw or Purple Cat's Paw	LE	Bivalvia	Wilson, Trousdale, Smith
Epioblasma torulosa torulosa	Tuberculed-blossom pearly mussel	LE	Bivalvia	Davidson*, Benton* - Historic. Eliminated from detailed consideration.
Etheostoma boschungi	Slackwater Darter	LT	Actinopterygii	Wayne
Etheostoma sp. D	Bluemask (=Jewel) Darter	LE	Actinopterygii	White, Warren
Falco peregrinus	Peregrine Falcon	LE	Aves	Not listed in study area – Eliminated from detailed consideration.
Hemistena lata	Cracking Pearlymussel	LE	Bivalvia	Wayne, Hardin
Lampsilis abrupta	Pink Mucket	LE	Bivalvia	Stewart, Wilson, Hardin, Decatur, Humphreys, Smith, Benton, Wayne*, Trousdale, Perry, MARSHALL
Lesquerella globosa	Short's Bladderpod	C	Magnoliopsida	Montgomery, Cheatham, Davidson, Trousdale, Smith
Lesquerella perforata	Spring Creek Bladderpod	LE	Magnoliopsida	Wilson

Lexingtonia dolabelloides	Slabside Pearlymussel	C	Bivalvia	Hardin* - Historic. Eliminated from detailed consideration.
Myotis grisescens	Gray Bat	LE	Mammalia	Stewart, Houston, Hardin, Montgomery, Cheatham, Sumner, Wilson, Smith, DeKalb, Putnam, White, Warren, Benton, Perry, Decatur, Wayne, CALLOWAY, TRIGG
Myotis sodalis	Indiana Bat	LE	Mammalia	Stewart, Montgomery, White, Warren, Perry, CALLOWAY, TRIGG
Noturus stanauli	Pygmy Madtom	LE	Actinopterygii	Humphreys
Obovaria retusa	Ring Pink	LE	Bivalvia	Smith, Benton*, Trousdale*, Humphreys*, Perry, Decatur*, Hardin*, MARSHALL, TRIGG
Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard	D	Reptilia	White
Orconectes shoupi	Nashville Crayfish	LE	Malacostraca	Davidson
Pegias fabula	Little-wing Pearlymussel	LE	Bivalvia	Warren
Platanthera integrilabia	White Fringeless Orchid	C	Liliopsida	Warren
Plethobasus cicatricosus	White Wartyback	LE	Bivalvia	Davidson*, Smith*, Hardin, DeKalb*, Perry*, Decatur*, Wayne*
Plethobasus cooperianus	Orange-foot Pimpleback	LE	Bivalvia	Benton*, Davidson*, DeKalb*, Trousdale*, Smith, Hardin, Decatur, Perry, Humphreys*, MARSHALL, Wayne*, Stewart*, TRIGG
Pleurobema clava	Clubshell	LE	Bivalvia	Hardin*,
Pleurobema gibberum	Cumberland Pigtoe	LE	Bivalvia	White, Warren
Pleurobema plenum	Rough Pigtoe	LE	Bivalvia	Davidson*, Trousdale*, Smith*, Hardin, Decatur*, Humphreys*, Perry*, Wayne*
Pseudanophthalmus colemanensis	A Cave Obligate Beetle	C	Insecta	Montgomery
Pseudanophthalmus insularis	Baker Station Cave Beetle	C	Insecta	Davidson
Pseudanophthalmus tiresias	Indian Grave Point Cave Beetle	C	Insecta	DeKalb
Quadrula sparsa	Appalachian Monkeyface	LE	Bivalvia	Not in study area – Eliminated from detailed consideration.
Sorex longirostris	Southeastern Shrew	D	Mammalia	White
Sterna antillarum athalassos	Interior Least Tern	LE	Aves	MARSHALL
Toxolasma cylindrella	Pale lilliput pearly mussel	LE	Bivalvia	Wayne*, Perry* - Historic. Eliminated from detailed consideration.
Typhlichthys subterraneus	Southern Cavefish	D	Actinopterygii	Not in study area – Eliminated from detailed consideration.
Villosa trabalis	Cumberland Bean	LE	Bivalvia	Not in study area – Eliminated from detailed consideration.

* - "historic" (pre-1970) record

All Caps – County in Kentucky

4.1 Birds

4.1.1 Piping Plover (*Charadrius melodus*)

4.1.1.1 Species Account Summary. The following information is adapted from U.S. Fish and Wildlife Service's Species Profile at http://ecos.fws.gov/docs/life_histories/B079.html. The piping plover is a small, stocky, sandy-colored bird resembling a sandpiper. The adult has yellow-orange legs, a black band across the forehead from eye to eye, and a black ring around the base of its neck. Like other plovers, it runs in short starts and stops. When still, the piping plover blends into the pale background of open, sandy habitat on outer beaches where it feeds and nests. The bird's name derives from its call notes, plaintive bell-like whistles which are often heard before the birds are seen. Piping plovers return to their breeding grounds in late March or early April. Following establishment of nesting territories and courtship rituals, the pair forms a depression in the sand. The nest is sometimes lined with small stones or fragments of shell. Both sexes incubate to constantly protect eggs from extreme temperatures. The average clutch size is four eggs and the precocial downy young immediately use the "peck-and-run" foraging behavior of adults. When predators or intruders come close, the young squat motionless on the sand while the parents attempt to attract the attention of the intruders to themselves, often by feigning a broken wing. Plovers will re-nest and fledglings from these late nesting efforts may not be flying until late August. Plovers often gather in groups on undisturbed beaches prior to their southward migration. By mid-September, both adult and young plovers will have departed from their wintering areas. Piping plovers may live to be 8-10 years old.

The historic breeding range of the Great Lakes population of piping plover encompasses the Great Lakes' shorelines in Illinois, Indiana, Michigan, Minnesota, Ohio, Pennsylvania, Wisconsin, New York and Ontario. These birds winter primarily on the Gulf Coast, in Texas, Louisiana, Alabama and Florida. Critical habitat for the Great Lakes Piping plover has been designated for breeding habitat along the shorelines of the Great Lakes in New York, Minnesota, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and Wisconsin. Critical habitat for wintering piping plovers has been designated along the Gulf Coast in Texas, Louisiana, Alabama and Florida.

Great Lakes piping plovers utilize the open, sandy beaches, barrier islands, and sand spits formed along the Great Lakes' perimeters by wave action. They do not inhabit lakeshore areas where high bluffs formed by severe erosion have replaced beach habitat. They prefer sparsely vegetation open sand, gravel, or cobble for a nest site. They forage along the rack line where invertebrates are most readily available. In the winter, they inhabit beaches, mudflats, and sandflats along the Gulf of Mexico and Atlantic coasts. Also barrier island beaches and spoil islands on the Gulf Intercoastal Waterway.

The piping plover nearly disappeared due to excessive hunting for the millinery trade during the 19th century. The Great Lakes population decline is attributed to losses of lakeshore habitat due to huge fluctuations in lake levels caused by intensive water management throughout the watershed and in the St. Lawrence River, as well as increased development and recreational use of beaches. Human disturbance often curtails breeding success. Developments near beaches also provide food that attracts increased numbers of predators such as raccoons, skunks, and foxes, and domestic pets. Stormtides may inundate nests.

4.1.1.2 Effects. Nesting sites are unlikely to be found in the study area. A slight decrease in water quality in the form of increased temperatures and lowered DO is the only impact identified that would occur throughout the study area. This decreased water quality would not affect the piping plover.

4.1.1.3 Cumulative Effects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the piping plover.

4.1.1.4 Determination. Based on the information above, a No Effect determination has been reached for this species.

4.1.2 Interior Least Tern (*Sterna antillarum athalassos*)

4.1.2.1 Species Account Summary. The following information is adapted from Tennessee Valley Authority 2005 and U.S. Fish and Wildlife Service. The least tern, as the name implies is the smallest of the tern subfamily (Sterninae). This smallest of the terns has a body length of approximately 9 inches (21 – 24 cm) and a wingspan of 20 inches (51 cm). The sexes are similar in appearance. The breeding adult has a black crown and nape, white forehead, black-tipped bill, gray back and dorsal wing surfaces, and snowy white underwing surfaces. In flight, the black wedge on the outer primaries and the short, deeply forked tail are conspicuous (U.S. Army Corps of Engineers 1998). The least tern feeds almost entirely on small fishes such as minnows and shiners. Its breeding biology primarily centers around 3 ecological factors: (1) the presence of bare or nearly bare alluvial islands or sandbars, (2) the existence of favorable water levels during the nesting seasons, and (3) the availability of food.

4.1.2.2 Effects. Nesting sites are unlikely to be found in the study area. A slight decrease in water quality in the form of increased temperatures and lowered DO would not affect the least tern.

4.1.2.3 Cumulative Effects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the least tern.

4.1.2.4 Determination. Based on the information above, a No Effect determination has been reached for this species.

4.2 Mammals

4.2.1 Gray Bat (*Myotis grisescens* - Howell)

4.2.1.1 Species Account Summary. The gray bat is the largest of its genus, having a forearm averaging 42 mm. in length and weighing up to 16 grams. The U.S. Fish and Wildlife Service (1991c) in its species account further describes the species as follows: "*One feature which distinguishes this species from all other eastern bats is its uni-colored dorsal fur. The other bats have bi- or tri-colored fur on their backs. Also, the gray bat's wing membrane connects to the foot at the ankle instead of at the base of the first toe, as in other species of Myotis. For a short period after molt in July or August, gray bats are dark gray; but their fur usually bleaches to russet between molts. This difference in fur color is especially apparent in females during their reproductive season in May or June.)"* Gray bats are considered a wide-ranging species, and are known from suitable caves over virtually the entire Cumberland and Tennessee navigation systems. The species was Federally listed as Endangered in 1976. Populations are considered stable and have increased across portions of its range. Gray bat colonies are residents exclusively of limestone caves or cave-like habitats, and migrate seasonally between maternity and hibernating caves. During the summer, the colonies are segregated into maternity caves and bachelor caves. Gray bats are highly selective concerning caves, and consequently as few as nine hibernating caves may house roughly 95 percent of the population. Flying insects that have an aquatic life cycle make up the majority of food consumed by gray bats. Consequently, gray bats feed primarily along reservoirs, streams and riparian habitats, particularly above aquatic macrophyte beds. Concentration of large numbers of gray bats into a relatively small number of caves makes the species particularly vulnerable to instances of habitat disturbance. Human intrusions into maternity caves causing young to perish and into hibernating caves causing individuals to starve are thought to be primarily responsible for the species decline. Other factors attributed to threatening the species are pesticide poisoning, reduction of insect prey because of stream degradation, and flooding of caves by impoundment or natural causes.

4.2.1.2 Effects. None of the factors implicated in the decline of the Indiana bat have any readily apparent relationship to poor water quality. A slight decrease in water quality in the form of increased temperatures and lowered DO would not affect the gray bat.

4.2.1.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the gray bat .

4.2.1.4 Determination. Based on the information above, a No Effect determination has been reached for the gray bat.

4.2.2 Indiana Bat (Myotis sodalis – Millen & Allen)

4.2.2.1 Species Account Summary. The Indiana bat is medium sized in comparison with the gray bat, and closely resembles the little brown bat (*Myotis lucifugus*), except for coloration (U.S. Fish and Wildlife Service, 1991c). The Indiana bat generally has a body less than 2 inches long and a wingspread of approximately 10 inches. Coloration is a dull grayish chestnut, and the basal portion of the hairs of the back is a dull lead color. The calcar (heel of the foot) has a strong keel or flap of skin. The species was Federally listed as Endangered in 1967, and, although important protections are in place, populations have continued to decline. Although the species ranges throughout most of the eastern portion of the United States, hibernating colonies are known only from Indiana, Missouri, and Kentucky where approximately 87 percent of the population hibernate in only 7 limestone caves. The Indiana bat has rigid requirements for temperature and relative humidity in hibernating caves, hence the high concentration of individuals hibernating in a few caves. During the summer Indiana bats have been found in limestone caves and cave-like habitats under bridges and in old buildings and maternity colonies may be found under loose bark and in the hollows of trees. Bats forage at a height of 7 to 98 feet; they feed primarily on moths and aquatic insects. Indiana bats may forage up to 3.1 miles from their roost site. Roost trees generally have exfoliating bark, which allows the bat to roost between the bark and bole of the tree. Cavities and crevices in trees may also be used for roosting. In addition to having exfoliating bark, roost trees must be of sufficient diameter. Preferred trees are nine inches in diameter at breast height (dbh), or larger. Bachelor males have been found in trees with loose bark as small as 3 inches dbh. Small numbers of Indiana bats have been recorded within 1 mile of six Tennessee and Cumberland River navigation projects; Pickwick, Wheeler, Guntersville, Barkley, and Nickajack (Tennessee Valley Authority, 2003). The bat's diet consists of insects and it forages through riparian and floodplain trees. The decline of the species is attributed to commercialization of roosting caves, activities changing the climate of hibernacula caves, destruction by vandals, disturbances by increasing numbers of spelunkers and bat banding programs, use as laboratory animals, and potential insecticide poisoning.

4.2.2.2 Effects. None of the factors implicated in the decline of the Indiana bat have any readily apparent relationship to poor water quality. A slight decrease in water quality in the form of increased temperatures and lowered DO is the only impact identified that would occur throughout the study area in which the Indiana bat is likely to be found. This decreased water quality would not affect the Indiana bat.

4.2.2.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Indiana bat .

4.2.2.4 Determination. Based on the information above, a No Effect determination has been reached for the Indiana bat.

4.3 Reptiles

4.3.1 Eastern Slender Glass Lizard (Ophisaurus attenuatus longicaudus)

4.3.1.1 Species Account Summary. The eastern slender glass lizard is deemed in need of management. This species account summary was adapted from the Virginia Department of Game and Inland Fisheries' description at http://www.dgif.state.va.us/wildlife/species/display.asp?id=030009 . This lizard looks like a snake, as it has no legs. From the head to the base of the tail, it measures as long as 13 in. (330 mm.) and including the tail, up to 41.9 in. (1,065 mm.). This lizard has a groove on each side of the body, and it is smooth and glossy, with scales that overlap. It has a tan stripe, with a narrow black stripe in the center that runs from head to tail, and stripes that run down the sides above and below the groove. The fragile tail is often broken and the regenerated part is a solid light brown. The eastern slender glass lizard is seldom seen, as it is very secretive and tends to hide in burrows or under dry grass.

This species is found in the coastal plain region in grasslands and pine woodlands with dry soils, and in the piedmont on dry, grassy ridges. It is always associated with grassy areas when found in urban/suburban areas and farms. This species lives in old rodent burrows and under grass mats, and winters underground.

This species feeds on a wide variety of invertebrates, including grasshoppers (appear to be preferred), snails, spiders, caterpillars, beetles, cave crickets, and the young of small mammals.

4.3.1.2 Effects. A slight decrease in water quality in the form of increased temperatures and lowered DO would not affect the eastern slender glass lizard.

4.3.1.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Eastern Slender Glass Lizard.

4.3.1.4 Determination. Based on the information above, a No Effect determination has been reached for the Eastern Slender Glass Lizard.

4.4 Insects

4.4.1 A Cave Obligate Beetle (*Pseudanophthalmus colemanensis*)

4.4.1.1 Species Account Summary. Little is known about this rare beetle called Coleman Cave Beetle *(Pseudanophthalmus colemanensis)*, which has only been found in three caves in Tennessee. TNC purchased a cave with the help of a private donor and a grant from the United States Fish and Wildlife Service. The cave and 3/4 acres will be transferred to the Tennessee Wildlife Resources Agency for ownership and management as an endangered species sanctuary.

4.4.1.2 Effects. This is a cave obligate species. No caves would be affected by the proposed lowering of Center Hill Lake. As decreased water quality in the Caney Fork and Cumberland Rivers is the only identified impact, it is believed that Pseudanophthalmus colemanensis would be unaffected.

4.4.1.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the cave obligate beetle *Pseudanophthalmus colemanensis*.

4.4.1.4 Determination. Based on the information above, a No Effect determination has been reached for the cave obligate beetle *Pseudanophthalmus colemanensis*.

4.4.2 Baker Station Cave Beetle (*Pseudanophthalmus insularis*)

4.4.1.1 Species Account Summary. The Baker Station Cave Beetle is an eyeless, lightly pigmented subterranean obligate ground beetle that is found in only one cave in Davidson County, Tennessee. Little is known about its behavior other than it eats detritus and small invertebrates, and is a scavenger although if the opportunity presents itself it probably takes live prey. It is listed as critically imperiled and possibly extirpated or extinct.

4.4.1.2 Effects. This is a cave obligate species found in a single cave in Davidson County. Altering the lake level at Center Hill would not in any way impact the cave or the beetle.

4.4.1.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Baker Station Cave Beetle.

4.4.1.4 Determination. Based on the information above, a No Effect determination has been reached for the Baker Station Cave Beetle.

4.4.3 Indian Grave Point Cave Beetle (*Pseudanophthalmus tiresias*)

4.4.1.1 Species Account Summary. Little is known about this cave obligate beetle. It is currently known only in Alabama, Maryland, Tennessee, and West Virginia. It is presumed to scavenge on detritus and small invertebrates, although if the opportunity presents itself it probably takes live prey.

4.4.1.2 Effects. This is a cave obligate species. No caves would be affected by the proposed lowering of Center Hill Lake. As decreased water quality in the Caney Fork and Cumberland Rivers is the only identified impact, it is believed that *Pseudanophthalmus tiresias* would be unaffected.

4.4.1.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Indian Grave Point Cave Beetle.

4.4.1.4 Determination. Based on the information above, a No Effect determination has been reached for the Indian Grave Point Cave Beetle.

4.5 Terrestrial Plants

4.5.1 Price's Potato-bean (*Apios priceana*)

4.5.1.1 Species Account Summary. Price's potato-bean is found in five states. It is currently thought extant at only 13 sites including 4 sites in Mississippi and 3 sites each in Alabama, Kentucky and Tennessee. Approximately 40 percent of its populations have not been sited in recent years. Only 5 of the extant sites support populations of any significant size (50 - individuals). Many of these populations are declining and are threatened by the adverse modification or loss of habitat through cattle grazing, trampling, clear-cutting and succession. Those sites near roadsides or powerline rights-of-way are potentially threatened by herbicide application.

4.5.1.2 Effects. Price's potato-bean is an upland plant. None of the possible effects of lowering Center Hill Lake, could possibly affect this plant.

4.5.1.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on Price's Potato-bean.

4.5.1.4 Determination. Based on the information above, a No Effect determination has been reached for Price's Potato-bean.

4.5.2 Braun's Rock-cress (*Arabis perstellata*)

4.5.2.1 Species Account Summary. This endangered species is restricted to two counties (Rutherford and Wilson) in Tennessee and three counties (Franklin, Owen, and Henry) in Kentucky. It is a perennial herb of the mustard family (Brassicaceae). It occurs on slopes composed of calcium carbonate, calcium, or limestone in moderately moist to almost dry forests. The soils at Arabis perstellata sites are limestone-derived, and a rock outcrop component is usually present in the soil complex. Arabis perstellata is presently known from 42 populations in two separate sections of the Interior Low Plateaus Physiographic Province—the Blue Grass Section (Kentucky) and the Central Basin Section (Tennessee). Both areas where this species is found are predominantly underlain by sediments of Ordovician age (510–438 million years ago) (Quarterman and Powell 1978). The Kentucky populations occur in Franklin, Henry, and Owen counties along the Kentucky River and its tributaries (primarily Elkhorn Creek). The Tennessee populations occur in Rutherford and Wilson counties, principally along the Stones River.

4.5.2.2 Effects. Braun's Rock-cress is an upland plant. None of the possible effects of lowering Center Hill Lake could possibly affect this plant.

4.5.2.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on Braun's Rockcress.

4.5.2.4 Determination. Based on the information above, a No Effect determination has been reached for the Braun's Rockcress.

4.5.3 Pyne's (Guthrie's) Ground-plum (*Astragalus bibullatus*)

4.5.3.1 Species Account Summary. Astragalus bibullatus (Guthrie's ground-plum) is a perennial member of the pea family (Fabaceae) that is presently known to exist only in Rutherford County in Tennessee's central basin. Guthrie's ground-plum is endemic to the cedar glades of middle Tennessee. All sites are associated with thin bedded, fossiliferous Lebanon limestone outcroppings that support the unique cedar glade communities founding Tennessee's central basin. The species only grows along glade margins with deeper soil or in areas within the glades .that are partially shaded. Soil depths vary between 5 and 20 cm (2 to 8 inches) at the known sites. Cedar glades are typically wet in winter and spring and dry and very hot in the summer and fall (Somers and Gunn 1990, Quarterman 1986).

4.5.3.2 Effects. Pyne's ground-plum is an upland plant found only in the cedar glades. None of the possible effects of lowering Center Hill Lake could possibly affect this plant.

4.5.3.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on Pyne's Ground-plum.

4.5.3.4 Determination. Based on the information above, a No Effect determination has been reached for Pyne's Ground-plum.

4.5.4 Cumberland Rosemary (*Conradina verticillata*)

4.5.4.1 Species Account Summary. Cumberland rosemary (Conradina verticillata Jennison), a shrub in the mint family (Lamiaceae), is endemic to the

Cumberland Plateau of north-central Tennessee and adjacent southeastern Kentucky. Cumberland rosemary is known from five counties in north-central Tennessee and one county in southeastern Kentucky (Figure 2). At present, 91 occurrences (colonies) are thought to be extant. (Occurrences believed to be extant are those that have been observed in the recent past.) These are along nine major streams of the Cumberland Plateau--Big South Fork River, New River, Clear Fork River, White Oak Creek, Caney Fork River, Obed River, Daddys Creek, Clear Creek, and Emory River (Tennessee Department of Environment and Conservation 1995, Kentucky State Nature Preserves Commission 1994). There are three distinct populations. Within these populations genetic exchange is believed to occur on a frequent basis, while it is less frequent between the populations. These populations are located along the following rivers: (1) the Big South Fork River and its tributaries in Morgan, Scott, and Fentress Counties; (2) the Obed River in Morgan and Cumberland Counties; and, (3) the Caney Fork River in Cumberland and White Counties. The locations in Kentucky are considered part of the Big South Fork River population of Tennessee (Figure 3). Although it is widespread along several of these streams, it is often disjunct and seldom abundant, often with only a single plant (see Appendix). There are fewer than ten locations that are known to have more than 100 clumps (see Life History section for explanation of clumps) and probably fewer than 4,000 total clumps from all known locations (Table 2). Population data for each extant occurrence is presented by stream or river in the Appendix.

One occurrence is assumed extirpated. Lucy Braun collected Conradina verticillata from a site 50 miles downstream of the type locality in McCreary County, Kentucky, within the area now inundated by Lake Cumberland, which was formed by the Wolf Creek Dam (Patrick and Wofford 1981). The current status of the type locality is not known. In 1979 and 1992, attempts were made to relocate Cumberland rosemary along the north bank of the Clear Fork in Fentress County, Tennessee. High water levels were detrimental to both search efforts (field search by Roulston in 1993, Patrick and Wofford 1981).

Cumberland rosemary grows in full to moderate sunlight in the floodplain of major streams flowing over sandstone bedrock. The substrate varies from expanses of deep, pure sand to densely rocky areas that are always well drained and devoid of organic matter. Plants occur on boulder bars, bouldery gravel bars, sandy gravel bars, terraces of sand on gradually sloped riverbanks and islands, and sandy pockets between boulders. Seasonal flooding occurs along these major Cumberland Plateau rivers and streams. Essential habitat requirements for Cumberland rosemary include periodic flooding to maintain openness, topographic features to enhance sand deposition, and periods of inundation of at least 2 weeks to induce rooting at the lower nodes of the stems (Service 1984).

The primary importance of the periodic flooding is probably the elimination or reduction of trees and shrubs that would out-compete Cumberland rosemary for light. Although it will tolerate moderate amounts of shade, the species will produce fewer flowers and appear less vigorous. Other possible benefits of flooding include the induction of roots at the nodes by inundation or sand deposition, thereby increasing the clump size; the downstream dispersal of seeds; and the transport and deposition of viable plant fragments downstream.

The duration, severity, and frequency of flooding varies greatly from year to year within, as well as between, populations. Available data show that some populations may be flooded three to seven times a year for up to 3 days at a time. Floods are most common during the winter (Pennington 1992).

Although Cumberland rosemary tolerates extended periods of submersion and thrives in full sunlight, it seldom, if ever, grows directly beside the normal (nonflooded) riverbed, probably because of the soil saturation associated with the higher water table at these locations. Such habitat constraints greatly limit the distribution of the species within a river system. The banks of Cumberland Plateau rivers are very steep in some areas and forested to the edge, leaving no marginal area of well-drained soil. With few exceptions, the only place where Cumberland rosemary is found in any abundance (more than 50 clumps) is on wide gravel/boulder bars of river bends or low-lying islands. These frequently occur where major tributaries enter the main channel, depositing sediment and widening the floodplain.

4.5.4.2 Effects. The only place within the study area that this plant is known to exist is in White County near the upper end of Center Hill Lake. As noted above, "it seldom, if ever, grows directly beside the normal (nonflooded) riverbed, probably because of the soil saturation associated with the higher water table at these locations." It is, therefore, unlikely that it would be growing directly adjacent to either Center Hill or any of the mainstem lakes. Even if it was present, the only identified impact of lowering Center Hill Lake is reduced water quality such as increased temperatures and lowered DO. This reduced water quality would not affect the Cumberland rosemary in any way.

4.5.4.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Cumberland Rosemary.

4.5.4.4 Determination. Based on the information above, a No Effect determination has been reached for the Cumberland Rosemary.

4.5.5 Leafy Prairie-clover (*Dalea foliosa*)

4.5.5.1 Species Account Summary. This plant is presently known from only one site in Alabama, seven sites in Tennessee, and four sites in Illinois. It is threatened throughout its range by habitat alteration; residential, commercial, or industrial development; livestock grazing; and conversion of its limited habitat to pasture. Dalea foliosa, a perennial, is a member of the pea family (Fabaceae) that has only been collected from Illinois, Tennessee, and Alabama. Dalea foliosa is typically found growing in close association with the cedar glades of central Tennessee and northern Alabama. However, it seems to prefer the deeper soil of the prairie-like areas along the boundaries of, and within, the rocky cedar glades (Smith and Wofford 1980). Only 7 populations of Dalea foliosa are known to survive in Tennessee, and most of these populations are small, containing fewer than 30 individual plants. Historically, the plant was known from five Rutherford County sites. One of these sites was destroyed by industrial construction, and the species has not been observed on three other Rutherford County sites in the recent past. In Rutherford County the only known currently occupied site is in a State park, and it contains 25 to 30 individuals. Wilson County supports one small privately owned population containing 12 plants. Marshall County had one known Dalea foliosa site, but the species has not been observed in the recent past and is likely extirpated from the county. Davidson County once supported four populations. One of the sites has been bulldozed for development and is considered to be lost to the species. Another site is slated for development and is expected to be lost, and two very small populations, discovered in 1985, have not been observed since their discovery. Williamson County supports one population of the species, and most of this site has been acquired through donation by The Nature Conservancy and is protected. However, a small portion remains in private ownership and could be lost. The largest and healthiest Tennessee population is owned by the Tennessee Valley Authority and is located in Maury County. This site is within the flood pool of the proposed Columbia Dam project and will be flooded if the project is constructed as originally proposed (See the "Summary of Factors Affecting the Species" section of this proposed rule for further discussion of this project). The Tennessee Department of Conservation conducted a survey of over 200 cedar glades and cedar glade remnants in the central basin of Tennessee during 1987 and 1988. Despite this thorough search of most of the available habitat for Dalea foliosa, no new populations of the species were found.

4.5.5.2 Effects. The leafy prairie-clover is an upland plant found in close association with the cedar glades. None of the possible effects of lowering Center Hill Lake could possibly affect this plant.

4.5.5.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Leafy Prairie-clover.

4.5.5.4 Determination. Based on the information above, a No Effect determination has been reached for the leafy prairie-clover.

4.5.6 Tennessee Coneflower (*Echinacea tennesseensis*)

4.5.6.1 Species Account Summary. The Tennessee purple coneflower), a native plant of Tennessee, is an Endangered species. There are, at present, only five known populations for E. tennesseensis, all in cedar glade communities and located within 14 miles of one another in Davidson, Rutherford, and Wilson Counties in middle Tennessee. All of the known natural colonies for Echinacea tennesseensis, past and present, are in cedar glades. Cedar glades are openings in forests that are dominated by red cedar (*Juniperus virginiana*) and where the bedrock, Lebanon limestone of Ordovician age, is exposed or covered by a very thin layer of soil. These glades provide an extremely harsh environment subject to extremes in light, temperature, and moisture (Freeman 1933, Turner 1966). Past and potential loss of this species; habitat due to residential development is threatening the continued existence of the species. Over-utilization of this species due to its esthetic and possibly medicinal qualities also poses a threat to this species.

4.5.6.2 Effects. The Tennessee coneflower is an upland plant found only in the cedar glades. None of the possible effects of lowering Center Hill Lake could possibly affect this plant.

4.5.6.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Tennessee Coneflower.

4.5.6.4 Determination. Based on the information above, a No Effect determination has been reached for the Tennessee Coneflower.

4.5.7 Short's Bladderpod (*Lesquerella globosa*)

4.5.7.1 Species Account Summary. Short’s bladderpod is a perennial member of the mustard family (Brassicaceae) that occurs in Indiana, Kentucky, and Tennessee. *Lesquerella globosa* grows on steep, rocky wooded slopes and talus areas. It also occurs along cliff tops and bases and cliff ledges. The species usually is found adjacent to rivers or streams and on south to west facing slopes. Most populations are closely associated with outcrops of calcareous rock (Shea 1993). The Tennessee populations occur within the Highland Rim and Central Basin sections of the Interior Low Plateau Province (Fenneman 1938, Quarterman and Powell 1978).

In 1993, Tennessee supported 11 populations of the species. In 1998, the Tennessee Department of Environment and Conservation (TNDEC) conducted extensive searches for additional populations of Short's bladderpod and revisited most of the previously known sites. Andrea Shea (TNDEC, pers. comm. 1999) reported that these searches revealed the presence of 7 additional sites for the species in Tennessee. These new sites varied in size from 3 to 60 plants. At the present time, there are 18 known locations for Short's bladderpod in Tennessee. Cheatham County has six sites. The two largest known populations occur in Cheatham County; one of these large sites contains 1,000 plants and the other contains 1,500 plants. The remaining four populations have 6, 6, 7, and 50 plants respectively. Davidson County has four sites that currently support the species. These vary in size from 13 to 50 plants. Jackson County has three locations supporting Short's bladderpod and these contain 3, 5, and 50 plants, respectively. Montgomery County has two populations; one of these contains 10 plants and the other 21 plants. Smith County also has two populations, one of which has 10 plants and the other has 30 plants. Trousdale County only supports one population which contained 100 to 150 plants in 1998. Estimates of the current (1998) population levels for all of the known Tennessee sites were provided by Andrea Shea (TNDEC, pers. comm. 1999). David Lincicome (TNDEC, pers. Comm.., 2004, 2005) stated that there has been no change in the status of the species in Tennessee.

4.5.7.2 Effects. Short's bladderpod is an upland plant. None of the possible effects of lowering Center Hill Lake would affect this plant.

4.5.7.3 Cumulative Affects. Shea (1993) notes that impoundments and artificial water level manipulation threatened and, in a case along the Cumberland River, have destroyed sites supporting the species. Many of the Short's bladderpod locations are adjacent to rivers and streams, and impoundment and water level manipulation still threaten the species. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Short's Bladderpod.

4.5.7.4 Determination. Based on the information above, a No Effect determination has been reached for the Short's Bladderpod.

4.5.8 Spring Creek Bladderpod (*Lesquerella perforata - Rollins*)

4.5.8.1 Species Account Summary. This rare plant is presently known from only a limited area within Tennessee's Central Basin. It is threatened by habitat alteration; residential, commercial, or industrial development; livestock grazing; conversion of its limited habitat to pasture; and habitat encroachment by woody vegetation and herbaceous perennials. *Lesquerella perforata* (Spring Creek bladderpod), described by R. C. Rollins (Rollins 1952), occurs within a small area in Wilson County in the vicinity of Lebanon, Tennessee. This species is typically found growing on flood plains. It requires annual disturbance in order to complete its life cycle. Historically, this disturbance was probably provided by periodic flooding of the streams along which it occurs. This flooding is thought to have removed the perennial grasses and woody plants that quickly invade the flood plains without regular natural or artificial disturbance. Cultivation of annual crops, such as corn, provides an excellent means of artificially maintaining the habitat, provided there is no fall plowing and herbicide use is limited. No-till farming techniques are believed to adversely affect the species because of the extensive use of herbicides required to successfully implement the technique. Row-crop cultivation, which avoids the use of fall plowing and delays spring plowing until the majority of the plants have set fruit, does not seem to adversely affect the species (Somers *et al.* 1993; Somers, Massachusetts Natural Heritage and Endangered Species Program, personal communication, 1992).

Lesquerella perforata is known from four populations consisting of 13 extant sites in Wilson County, Tennessee. Three additional sites no longer support the species. One of the extant populations occurs along Spring Creek and consists of five groups of plants. Another, consisting of four groups of plants, is found along Lower Bartons Creek. Two sites are located farther upstream and are designated the Middle Bartons Creek population. The fourth population consists of two sites and is located along a tributary of Bartons Creek. All of the known sites for the species are found within a few miles of each other; with only one exception, sites are within the flood plains of Spring and Bartons Creeks or within the floodplain of a Bartons Creek tributary. The only non-floodplain location is within a gladey area slightly above the floodplain of Spring Creek (Somers *et al.* 1993). All of the known sites supporting *L. perforata* are privately owned, and none are protected through cooperative management agreements with the State or the Service.

4.5.8.2 Effects. Spring Creek bladderpod appears to have been dependent on the fluctuation of water levels disturbing the soil and drowning its competition. It would not be disturbed by any of the possible effects of lowering Center Hill Lake.

4.5.8.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Spring Creek Bladderpod.

4.5.8.4 Determination. Based on the information above, a No Effect determination has been reached for the Spring Creek Bladderpod.

4.5.9 White Fringeless Orchid (*Platanthera integrilabia*)

4.5.9.1 Species Account Summary. White fringeless orchid is a perennial herb with a light green, 60 centimeter (cm) (23 inches (in)) long, stem that arises from a tuber. The leaves are alternate with entire margins and are narrowly elliptic to lanceolate in shape. The lower leaves are 20 cm (8 in) long and 3 cm (1 in) wide. The upper stem leaves are much smaller. The white flowers are borne in a loose cluster at the end of the stem. The upper two flower petals are about 7 millimeters (mm) (0.3 in) long and the lower petal (the lip) is about 13 mm (0.5 in) long. The plants flower from late July through September and the small narrow fruiting capsule matures in October (Shea 1992).

Platanthera integrilabia grows in wet, boggy areas at the head of streams and on seepage slopes. It is often associated with Sphagnum in partially, but not fully, shaded areas. The species currently occurs within the Appalachian Plateau Physiographic Province in Kentucky, Tennessee, and Alabama, the Coastal Plain Physiographic Province in Alabama, and the Blue Ridge Province in Georgia and Tennessee (Shea 1992).

Historically, there were at least 90 populations of Platanthera integrilabia. Currently there are only 53 extant sites supporting the species. The species was originally known from Alabama, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. It has been extirpated from Mississippi, North Carolina, and Virginia.

In Tennessee, Franklin County supports five privately owned Platanthera integrilabia sites. Four of these are very small and contained 2, 3, 5 and 10 plants, respectively, in 1991. The fourth site is larger and contained 200 to 300 plants in 1998. Grundy County supports nine populations. Three of these are on State owned lands and in the most recent surveys contained 6, 6 and 34 plants, respectively. The remaining six sites are on privately owned land and in the most recent surveys contained 0, 4, 118, 150, 250, and 1,000+ plants, respectively. Sequatchie County has three privately owned populations, one of these had 7 flowering plants in 1991, the second had 12 in that same year, and the third had 91 plants in 1996. Marion County has three populations. Two of the Marion County sites are small and privately owned, one of these had 2 plants and the other 10 plants in 1991. The third site is State owned and supported 65 flowering plants in 1998. Van Buren County has four privately owned sites supporting P. integrilabia. In the most recent surveys of these populations, they contained 76, 86, 128, and 525 flowering plants, respectively. Bledsoe County has two State owned sites; one had 50 plants in 1989 and the other had 600 plants in 1998. There are two federally owned sites in the State, one is in McMinn County on land managed as a botanical area by the Cherokee National Forest. In 1998, thousands of plants were observed at this site. The other federally owned site is also on the Cherokee National Forest and is in Polk County. In 1996, this site contained 40 plants.

Current threats include invasive plants, poor land use practices upstream or upslope of the sites and, at least in the past, herbivory (deer), and the present or threatened destruction, modification, or curtailment of its habitat or range. Little, if any, vegetative reproduction takes place in Platanthera integrilabia, and it is apparently primarily dependent upon sexual reproduction. Zettler and Fairey (1990) reported that only 2.8 percent to 4.6 percent of the plants within a population flower in any given year and of these, only 6.9 percent to 20.3 percent will set seed. This results in a very low production of seeds and, consequently, a limited ability to reproduce at most sites. White (1998) notes that the recovery of this species will be dependent upon active habitat management rather than just habitat preservation. Because of the species' dependence upon moderate to high light levels, some type of active management to prevent complete canopy closure is required at most locations. Invasive nonnative plants such as Japanese honeysuckle (Lonicera japonica) and kudzu (Pueraria lobata) threaten several sites and, if left uncontrolled, can extirpate the species (Zettler and Fairey 1990).

4.5.9.2 Effects. The white fringeless orchid is found in wet, boggy areas at the head of streams and on seepage slopes above or outside the zone of hydraulic influence. The only place within the study area it is found is in Warren County, Tennessee above the headwaters of Center Hill Lake. None of the possible effects of lowering Center Hill Lake could possibly affect this plant.

4.5.9.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the white fringeless orchid.

4.5.9.4 Determination. Based on the information above, a No Effect determination has been reached for the white fringeless orchid.

4.6 Crustaceans

4.6.1 Nashville Crayfish (*Orconectes shoupi*)

4.6.1.1 Species Account Summary. This species is currently known to exist only in the Mill Creek basin in Davidson and Williamson Counties. Tennessee. The species is threatened by siltation, stream alterations, and general water quality deterioration resulting from development pressures in the urbanized areas surrounding Xashvi1le. Tennessee. The species' limited distribution also makes it vulnerable to a single catastrophic event, such as a toxic chemical spill or other contamination. The Nashville crayfish, which attains a length of over 6 inches (15 centimeters], has been observed to inhabit pools and riffle areas with moderate current. Very little is known concerning the species' biology, but, like related crayfish, it probably feeds on vegetation fragments and animal matter. Reproduction occurs in the winter months, and females have been observed carrying eggs in the spring. The species' restricted range makes it vulnerable to toxic chemical spills. The species is also subjected to water quality and other habitat deterioration associated with urban runoff, land disturbance, and development within the Mill Creek watershed.

4.6.1.2 Effects. The Nashville crayfish is only found in Mill Creek in the pool and riffle areas, i.e., above the Cheatham Lake pool. As such, it would not be disturbed by any of the possible effects of lowering Center Hill Lake.

4.6.1.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Nashville Crayfish. A flood control project being planned for the Mill Creek basin by the U.S. Army Corps of Engineers-(COE) could also impact the species, but separate consultation will be pursued, as appropriate for the feasibility study.

4.6.1.4 Determination. Based on the information above, a No Effect determination has been reached for the Nashville Crayfish.

4.7 Fish

4.7.1 Slackwater Darter (*Etheostoma boschungi*)

4.7.1.1 Species Account Summary. The area occupied by the slackwater darter is the Highland Rim of the Nashville Basin. Presently it occupies headwater streams arising from the highlands of Lawrence and Wayne counties, Tennessee. The darter is not known from the Elk River, the largest tributary in the south bend of the Tennessee River. However, the Elk interposes the Buffalo and Flint rivers, two streams where slackwater darters are found. They are also absent from Bear Creek, the largest north-flowing tributary. The slackwater darters occur in two distinctly different, but necessarily adjacent, habitats: non-breeding and breeding habitats. The two distinctly different habitats must be adjacent; that is, the fish must be able to swim from stream to spawning area and vice versa. The species typically inhabits gentle riffles and slackwater areas of small to medium-sized shallow, upland tributary streams no more than 40ft wide and less than 7ft deep (Williams and Robinson 1980). Breeding sites are usually 30-45cm above the adjacent streams, and therefore depend on heavy rains to raise the stream level and allow the darters access to the sites. Breeding site substrates are characterized by Lee cherty silt loams, Lobelville cherty loam, and Staffell, Bodine and Etowah silt loams. At these sites the water is usually about 4-8cm deep and flows slowly into an adjacent stream.

Slackwater darter populations are affected by any factor that negatively influences their habitat, both breeding and non-breeding habitat. Increased development has caused erosion and draining of areas with shallow groundwater limiting slackwater darter breeding habitat. Farming and cattle are the principal industries surrounding the darter's habitat, which has exposed darter habitat to pesticides, herbicides, fertilizers, and stockyard runoff. Other threats include degradation of surface and groundwater caused by the intrusion of toxins and industrial and domestic wastes from sewage lines and septic tank seepage. The slackwater darters are also threatened by predation from the green sunfish, *Lepomis cyanellus,* and the pirate perch, *Aphredoderus sayanus*.

Since breeding sites are located above the stream level any factor that limits accessibility to the sites would be detrimental to the darter population. Factors would include those listed under "Past Threats" with the inclusion of a drought.

4.7.1.2 Effects. The slackwater darter is not found in the Cumberland River or any of its tributaries. Its inclusion in this BA is based on its presence in streams tributary to Kentucky Lake. As noted above, The species typically inhabits gentle riffles and slackwater areas of small to medium-sized shallow, upland tributary streams no more than 40ft wide and less than 7ft deep, i.e., It would not be found in Kentucky Lake itself. None of the possible effects of lowering Center Hill Lake would affect the water quality in the Kentucky Lake tributaries.

4.7.1.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the slackwater darter.

4.7.1.4 Determination. Based on the information above, a No Effect determination has been reached for the slackwater darter.

4.7.2 Bluemask (=Jewel) Darter (Doration) (*Etheostoma sp. D*)

4.7.2.1 Species Account Summary. The bluemask darter is a small (1¾-inch) fish, closely related to E. stigmaeum. Breeding males are nearly covered by a bright blue color. Females and non-breeding males are not as brightly colored. They have six dark saddle-like markings across the back and seven to eight lateral blotches. The species inhabits areas of slow to moderate current over sand and fine gravel, a habitat type that is very limited in some of the occupied streams, The bluemask darter is endemic to the Caney Fork River system (above Great Falls), Cumberland River basin, in central Tennessee. Based on current and historic records reviewed by Layman (1991), the species has been collected from five rivers in the Caney Fork River system—Upper Caney Fork River, Collins River, Rocky River, Calfkiller River, and Cane Creek in Grundy, Warren, Van Buren, and White Counties. A 1991 fish survey (Layman 1991) of the Caney Fork River system above and below Great Falls revealed that the species is now restricted to isolated populations in reaches of four rivers in the Caney Fork River system—Cane Creek, Van Buren County: Collins River, Warren and Grundy Counties; Rocky River, Van Buren County; and Upper Caney Fork River, White County. The bluemask darter has been impacted by such factors as impoundments, water withdrawals, and the general deterioration of water and substrate quality resulting from siltation and other pollutants contributed by coal mining, gravel mining, poor land use practices, water withdrawal, and waste discharges. These factors continue to impact the species and its habitat.

4.7.2.2 Effects. Based on the above information, the bluemask darter is only found in streams above the headwaters of Center Hill Lake. None of the possible effects of lowering Center Hill Lake would affect the bluemask darter.

4.7.2.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the bluemask darter.

4.7.2.4 Determination. Based on the information above, a No Effect determination has been reached for the bluemask darter.

4.7.3Pygmy Madtom (*Noturus stanauli*)

4.7.3.1 Species Account Summary. The pygmy madtom is a member of the Ictaluridae family. This species is the smallest of the known madtoms reaching a maximum length of 1.5 inches (Etnier and Jenkins 1980). The average life span of most madtoms is 2 or 3 years. Etnier and Jenkins (1980) noted that only two age groups were evident in collections of the species, indicating a life span of 1+ years. Madtoms almost exclusively prey on aquatic insect larvae. Most authors have suggested that they are primarily opportunistic feeders and take prey items in proportion to their abundance (Starnes and Starnes 1985, Gutowski and Stauffer 1990).

Much of the species' life history is unknown. However, much can be inferred from comparisons with closely related species. Related madtoms nest in cavities beneath slabrocks and at times use other cover objects, such as cans and bottles. As native mussels are abundant in pygmy madtom habitat, it is possible that this species might use empty mussel shells for nesting cover. Reproduction likely occurs from spring to early summer; smoky madtom and least madtom reproduction occurs between late May and mid-July (Dinkins and Shute 1993).

The species has been collected from only two short river reaches separated by about 600 river miles (Etnier and Jenkins 1980, O'Bara 1991). It has been taken from the Duck River, Humphreys, and Hickman Counties, Tennessee; and from the Clinch River, Hancock County, Tennessee. In 1993, three pygmy madtoms were taken in the Duck River, Hickman County (Saylor, Tennessee Valley Authority, *in litt*., 1993). Etnier and Jenkins (1980), in their description of this species, reported that it had been taken in only about one-half of the collections made at the Clinch River and only about one-fourth of the collection at the Duck River site.

Pygmy madtoms occur in moderate to large rivers, in shallow shoals where the current is moderate to strong, and there is pea-sized gravel or fine sand substrates. Although there are no observations of seasonal habitat shifts, the closely related smoky madtom is known to switch from riffles to overwinter in shallow pools (Dinkins 1984). Many individuals are also found in the flowing portions of pools during the reproductive season (Dinkins and Shute 1993). The Duck River where the species has historically been taken is being seriously threatened by stream bank erosion. The runoff from large urban areas has degraded water and substrate quality.

As the two known populations are isolated from each other by impoundments, recolonization of any extirpated population would not be possible without human intervention. The absence of natural gene flow among populations of these fishes leaves the long-term genetic viability of these isolated populations in question.

Additionally, several madtom species have, for unexplained reasons, been extirpated from portions of their range. Etnier and Jenkins (1980) speculated that this may "...in addition to visible habitat degradation be related to their being unable to cope with olfactory 'noise' being added to riverine ecosystems in the form of a wide variety of complex organic chemicals that may occur only in trace amounts." If madtoms are adversely impacted by increased concentrations of complex organic chemicals, an increase in the presence of these materials could be a problem for the pygmy madtom.

4.7.3.2 Effects. The pygmy madtom was included in this BA because one of their two known populations occurs in the Duck River, a tributary of Kentucky Lake. Because this population is in a tributary area and therefore upstream of any possible effects of any possible influence by the proposed lowering of Center Hill Lake it is unlikely that the pygmy madtom could be affected in any way.

4.7.3.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the pygmy madtom.

4.7.3.4 Determination. Based on the information above, a No Effect determination has been reached for the pygmy madtom.

4.8 Mussels

Parmalee and Bogan (1998) provided a brief synopsis on unionoid faunal provinces of North America, which is summarized in this section. Approximately one-third of the nearly 1000 freshwater mussels species in the world have been recorded in North America. Through taxonomic studies, mussel surveys, and collection, it was recognized that the freshwater mussel species within North America congregated in distinct geographic regions termed unionoid faunal provinces. Boundaries were marked by the river systems they drained, and the mussel fauna that was endemic within each province. Approximately 45 mussel species that were historically confined to the Cumberland and Tennessee River drainages were called Cumberlandian species. Species included in this Biological Assessment; the Dromedary pearlymussel (*Dromus dromas*, Lea, 1834), Cumberlandian combshell (*Epioblasma brevidens*, Lea, 1834), and Oyster mussel (*Epiobasma capsaeformis*, Lea, 1834) are Cumberlandian mussels. The Cumberlandian province nests within the Mississippi River drainage basin that is known as the Interior Basin (Mississippian) province. Mussel species recorded in this region were historically widely distributed. Other species included in this Biological Assessment; the Fanshell (*Cyprogenia stegaria*), Pink mucket (*Lampsilis abrupta*), Cracking pearlymussel (*Hemistena lata*), White wartyback (*Plethobasus cicatricosus*), Orangefoot pimpleback (*Plethobasus cooperianus*), Clubshell (*Pleurobema clava*), and the Rough pigtoe (*Pleurobema plenum*) are species that were historically found in the Interior Basin province. Presently, the mussel fauna in the Nashville District reflect a blend of species represented in these two unionoid faunal provinces. Cumberlandian mussels tend to be somewhat confined to the Tennessee and Cumberland River systems, however species from the broader Interior Basin have been able to spread into and colonize a large portion of the Cumberlandian province.

Impoundments result in the dramatic modification of riffle and shoal habitats and the resulting loss of mussel resources, especially in larger rivers. Impoundment impacts are most profound in riffle and shoal areas, which harbor the largest assemblages of mussel species. Dams interrupt most of a river's ecological processes by modifying flood pulses; controlling impounded water elevations; altering water flow, sediments, nutrients, energy inputs and outputs; increasing depth; decreasing habitat heterogeneity; and decreasing stability due to subsequent sedimentation. The reproductive process of riverine mussels is generally disrupted by impoundments making mussels unable to successfully reproduce and recruit under reservoir conditions.

In addition, dams can also seriously alter downstream water quality and riverine habitat, and negatively impact tailwater mussel populations. These changes include thermal alterations immediately below dams; changes in channel characteristics, habitat availability, and flow regime; daily discharge fluctuations; increased silt loads; and altered host fish communities. Coldwater releases from large non-navigational dams and scouring of the river bed from highly fluctuating, turbulent tailwater flows have also been implicated in the demise of mussel faunas.

Population losses due to impoundments have probably contributed more to the decline of the mussels and other Cumberlandian Region mussels than any other single factor. Contaminants contained in point and non-point discharges can degrade water and substrate quality and adversely impact mussel populations. The effects are especially profound on juvenile mussels, which can readily ingest contaminants, and glochidia, which appear to be very sensitive to certain toxicants. Mussels are very intolerant of heavy metals, and even at low levels, certain heavy metals may inhibit glochidial attachment to fish hosts.

Water pollution over historic times has been a slow but widespread process often attributed to poor land use practices. Water quality degradation included siltation, sediment contamination, excessive nutrient, fertilizer, and urban runoff, as well as point and nonpoint source pollution. Siltation is the largest single pollutant, affecting over 4,800 miles of streams. Siltation fills navigation channels, increasing the need for maintenance dredging and disposal (TN 305(b) Report, 2002). Point and nonpoint Source pollution control are implemented by non-Corps agencies.

Exploitation has affected all mussel populations. Native Americans used them for food and tools; however decimation of large mussel beds resulted from pearl collecting, the pearl button industry, and most recently, the cultured pearl industry. As commercial size mussels decline, there is the potential for over harvesting and illegal take. Currently, however, a marked decline in the cultured pearl industry has greatly reduced the market demand for freshwater mussel shells. It is unknown when and if the market demand will reverse.

Natural predation is a concern for remnant mussel populations. Muskrats (*Ondatra zibethicus*) prey upon adult and sub-adult mussels while crayfish, fish, and other invertebrates prey upon the juvenile mussels. Exotic invasive aquatic species pose additional threats. Asiatic Clams (*Corbicula fluminea*) and Zebra mussels (*Dreissena polymorpha*) compete with native freshwater mussels. Zebra mussels pose the greatest threat because of their ability to colonize on native mussels. Attachment on to any waterborne vessel or boat trailer has facilitated the spread of these mussels.

Commercial sand and gravel dredging is a regulated activity that permanently removes sand, gravel, and benthic organisms from the river bottom. Secondary impacts include a localized temporary increase in turbidity and a change in the river bottom topography. Sand and gravel extraction creates underwater holes and furrows tens of feet deeper than the natural river bottom elevation. Permitting helps protect mussel beds by confining extraction to disturbed areas to reduce the likelihood of encountering mussels.

Current threats to the species listed above are not totally understood (USFWS, 1985) but are predominantly anthropic in nature. The activities are under the authority of varying federal, state, local, and private entities.

Water levels are regulated on the Cumberland and Tennessee Rivers by the Corps and TVA respectively to maintain the minimum 9-foot channel depth and, under emergency conditions, to rescue grounded barges. Water level regulation for these purposes may be accomplished by holding pool levels, by releases from one navigation project to another, or by a combination of both. The result is a kind of minimum flow, or, at least, avoidance of dewatering some mussel habitat outside the channel as could occur in absence of the navigation purpose. Riverine conditions found below dams provide refugia for mussel populations in the over bank and back chutes of islands. Mussel sanctuaries have been established below several locks and dams by state natural resource agencies. In summation, this feature may positively affect listed species by maintaining a status quo of existing populations.

While not a direct result of Corps O&M activities, zebra mussels were introduced into the inland waterways via bilge water from commercial vessels and have spread quickly throughout the inland navigation system and other water bodies by attaching to both commercial and recreational vessels. Zebra mussels affect native mussel species at all ages. Filtering water containing glochidia reduces recruitment. Attaching to juvenile and adult mussels impairs growth, reproduction, and survival if the mussel is unable to open to feed, breath, or reproduce. The loss of all ages indirectly results in lower population densities. The Corps and TVA have evaluated control of zebra mussels and related species at their facilities (U. S. Army Corps of Engineers, Nashville District and Tennessee Valley Authority, 1992). The Corps found that implementing control of Zebra mussels and related species at its facilities would have no affect on listed mussel species, but that an increase in zebra mussel populations, independent of Corps activities, could have a profoundly negative impact on native mussels. Since that time, Corps observations are that the expected zebra mussel population explosion has not materialized and that, instead, populations seem to have waned somewhat. Zebra mussel control measures are still “on the shelf” should they be needed, but the nexus of any invasion may be more toward recreational navigation – i.e. with or without commercial navigation and O&M activities, zebra mussels may continue to spread. Long-term impact to the viability of freshwater mussel communities is unknown.

Cumulative impacts to the aquatic environment from non-federal actions have additionally contributed to the decline, endangerment or extinction of many mussel species in the last century. The direct destruction of species or habitat and the indirect impact of degrading habitat and water quality, though individually minor, have collectively resulted in significant cumulative actions.

As the human population increases, human threats to the remaining populations of freshwater mussels will continue to grow. Urbanization and the need for water supply, wastewater treatment, waterborne recreation and mineral extraction are expected to increase with future development. Permits for a host of activities (bridge construction, utility crossings, diffusion pipe outfalls, etc.) that potentially affect mussels, will continue to be requested. Secondary impacts may include urban runoff, sedimentation, water pollution, sediment contamination, clean water scarcity, additional marinas, spills, and the spread of exotics. These activities may combine to adversely affect mussels. On the other hand, regulatory programs primarily aimed at improving water quality (Total Maximum Daily Load, NPDES, Stormwater Pollution Prevention Permits, etc) will be beneficial to mussels. With or without O&M activities, increased human-related changes in the watershed are expected to continue and likely to increase in the future. Whether existing and future conservation and regulatory programs will prevent these changes from translating to increased impacts on mussels remains to be seen.

4.8.1 Spectaclecase (*Cumberlandia monodonta*)

4.8.1.1 Species Account Summary. The spectaclecase, a candidate species, is a large mussel that reaches at least 9.25 inches in length. As a group, mussels are extremely long-lived, particularly among the margaritiferids (e.g., eastern pearlshell, *Margaritifera margaritifera*, up to 200 years [Mutvei et al. 1994]; Louisiana pearlshell, *M. hembeli*, up to 75 years [Johnson and Brown 1998]). Baird (2000) aged 278 specimens of the spectaclecase in Missouri by sectioning the hinge ligament. The maximum age he determined was 56 years, but he surmised that some large individuals may have been older. A very large specimen (9.25 inches) from the St. Croix River, Minnesota and Wisconsin, was estimated (qualitatively based on external growth rings counts) to be aged at approximately 70 years (Havlik 1994).

Hermaphroditism may occur in the spectaclecase (van der Schalie 1966), although it is not generally reported in the literature, nor from Baird's (2000) life history study in Missouri. Another margaritiferid, the eastern pearlshell, has been shown to produce glochidia hermaphroditically (Bauer 1987). This reproductive mechanism, which is thought to be rare in dense populations, may be implemented when populations exhibit low densities and high dispersion levels. Females changing to hermaphrodites may be an adaptive response (Bauer 1987) assuring that a recruitment class may not be lost in small populations. If hermaphroditism does occur in the spectaclecase, it may explain the occurrence of small, but persistent populations (e.g., in cold tailwaters receiving hypolimnetic discharges from large dams [Gordon and Layzer 1989]).

The spectaclecase occurs in large rivers and is a habitat-specialist, relative to other mussel species. Baird (2000) noted its occurrence on outside river bends below bluff lines. It most often inhabits riverine microhabitats that are sheltered from the main force of current. Utterback's (1915) record of this species in the Northwest Missouri Lakes is puzzling but may refer to seasonally flooded oxbow lakes along the Missouri River. It occurs in substrates from mud and sand to gravel, cobble, and boulders in relatively shallow riffles and shoals with slow to swift current (Buchanan 1980, Parmalee and Bogan 1998, Baird 2000). According to Stansbery (1967), the spectaclecase is usually found in firm mud between large rocks in quiet water very near the interface with swift currents. Specimens also have been reported in tree stumps, root masses, and in beds of rooted vegetation (Stansbery 1967, Oesch 1984). Similar to other margaritiferids, spectaclecase tend to be aggregated (Gordon and Layzer 1989), particularly under slab boulders or bedrock shelves (Call 1900, Hinkley 1906, Buchanan 1980, Parmalee and Bogan 1998, Baird 2000) where they are protected from the current. Up to 200 specimens have been reported from under a single large slab in the Tennessee River at Muscle Shoals (Hinkley 1906). Unlike most species that move about to some degree, the spectaclecase may seldom, if ever, move except to burrow deeper; they may die from stranding during droughts (Oesch 1984).

The spectaclecase was considered as extant if live or fresh-dead specimens have been collected since the mid-1980s. Extant populations of the spectaclecase are known from 20 streams in 10 states and three Service regions. These include the Cumberland River system (Caney Fork) and the Tennessee River system (Tennessee River, Clinch, Nolichucky, Duck Rivers). Although the spectaclecase is not listed on the Cookeville website as occurring in the study area, a single specimen was found during an intensive survey of the Caney Fork (Lazer et al, 1993)

The decline of the spectaclecase is primarily the result of habitat loss and degradation (Neves 1991). These losses have been documented well since the mid-19th century (Higgins 1858). Chief among the causes of decline are impoundments, channelization, chemical contaminants, mining, and sedimentation (Williams et al. 1993; Neves 1991, 1993; Neves et al. 1997; Watters 2000)

Population losses due to impoundments have probably contributed more to the decline and imperilment of the spectaclecase than any other factor. Dams impound large river habitats throughout almost the entire range of the species. These impoundments have left short and isolated patches of remnant habitat, typically just downstream of the dams. Dams impound most of the Tennessee and Cumberland Rivers and many of their tributaries; these systems were once strongholds for the spectaclecase (Ortmann 1924).

Dams either impound or alter the temperature regimes of approximately 90 percent of the 562-mile length of the Cumberland River downstream of Cumberland Falls. Other major U.S. Army Corps of Engineers (Corps) impoundments on Cumberland River tributaries (e.g., Stones River, Caney Fork) have inundated an additional 100 miles or more of riverine habitat for the spectaclecase. Coldwater releases from Wolf Creek, Dale Hollow (Obey River), and Center Hill (Caney Fork) Dams continue to affect adversely riverine habitat for the spectaclecase in the Cumberland River system. One-third of the streams that the spectaclecase historically occupied are in the Tennessee and Cumberland River systems.

The effects of contaminants are especially profound on juvenile mussels (Robison et al. 1996), which readily ingest contaminants adsorbed to sediment particles while feeding, and on glochidia, which appear to be very sensitive to toxicants (Goudreau et al. 1993, Jacobson et al. 1997). Mussels are very intolerant of heavy metals (Keller and Zam 1991, Havlik and Marking 1987), and even at low levels, certain heavy metals may inhibit glochidial attachment to fish hosts (Huebner and Pynnönen 1992). Cadmium appears to be the heavy metal most toxic to mussels (Havlik and Marking 1987), although chromium, copper, mercury, and zinc also adversely affect biological processes (Naimo 1995, Keller and Zam 1991, Jacobson et al. 1997, Keller and Lydy 1997). Bogan and Parmalee (1983) considered the spectaclecase "apparently...unable to survive even minimal amounts of organic pollution or chemical waste."

4.8.1.2 Effects. Although the spectaclecase may be still extant in the Caney Fork River, the water releases from Center Hill Dam are so cold as to preclude reproduction. The Caney Fork has been classified as a trout stream by the State of Tennessee and any attempt to intentionally warm the water above 20° C would require approval from the state's water board. Nevertheless, lowering Center Hill Lake's levels will reduce the cold water storage which could result in somewhat warmer waters until the repairs to the dam are completed. Although it is unlikely, if a remnant population does exist below Center Hill it may be able to reproduce for a short time. Of more concern, perhaps, is the possibility of reduced water quality. Although the impact from Center Hill as compared to the entire Cumberland River system is minor, if Center Hill does not store and release its customary volumes of water during the summer months, all aquatic species downstream from Center Hill Dam could incur some slight additional stress. This would mimic to some extent what would occur in a natural system during low summer flows. Stressors would primarily be in the form of lowered DO and increased temperatures, but would also include less dilution of pollutants being discharged into the river. For pollution intolerant species such as the spectaclecase this could be particularly important.

4.8.1.3 Cumulative Affects. The impact of Center Hill on the Cumberland River System in and of itself would be minor. However at the same time Wolf Creek Dam is also undergoing necessary repairs. In the interest of public safety and to relieve pressure on the foundation of Wolf Creek Dam, Lake Cumberland has been lowered also. Flows from Wolf Creek Dam are significantly lower than what the public has become accustomed to. Anticipated cumulative affects include significantly changed and reduced water quality for all reaches below Wolf Creek

Dam including lower DO, increased water temperatures, and lessened dilution of pollutants. Due to the decreased flows and the commitment of a minimum flow of at least 3,000 cubic feet per second (cfs) below Barkley Lock and Dam, water is flowing from Kentucky Lake, through the canal, into Lake Barkley. Kentucky Lake is, therefore, currently protected from the water quality impacts of the Cumberland River.

4.8.1.4 Determination. Based on the information above, a May Effect But Not Likely to Adversely Affect determination has been reached for the spectaclecase.

4.8.2 Fanshell Pearly Mussel (*Cyprogenia stegaria*)

4.8.2.1. Species Account Summary. The fanshell is a medium-sized (reaching up to approximately 80 mm in length) freshwater mussel with light green or yellow with green mottling or rays (USFWS 2003). Like other freshwater mussels, the fanshell feeds by filtering food particles from the water column. The specific food habits of the species are unknown, but other juvenile and adult freshwater mussels have been documented to feed on detritus, diatoms, phytoplankton, and zooplankton (Churchill and Lewis 1924). The diet of fanshell glochidia, like other freshwater mussels, comprises water (until encysted on a fish host) and fish body fluids (once encysted).

The reproductive cycle of the fanshell is similar to that of other native freshwater mussels. Males release sperm into the water column; the sperm are then taken in by the females through their siphons during feeding and respiration. The females retain the fertilized eggs in their gills until the larvae (glochidia) fully develop. The mussel glochidia are released into the water, and within a few days they must attach to the appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. The species is a long-term brooder and holds glochidia overwinter for a spring release (Ortmann 1919). Fanshell glochidia are released in the form of a unique spiral worm-like conglutinate suggesting that this species relies on fish hosts that visually search for food (USFWS 1991). Recent induced infestations of glochidia on nine of sixteen fish species tested indicate that the following species are suitable hosts: mottled sculpin (*Cottus bairdi*), banded sculpin (*Cottus carolinae*), greenside darter (*Etheostoma blennioides*), snubnose darter (*Etheostoma simoterum*), banded darter (*Etheostoma zonale*), tangerine darter (*Percina aurantiaca*), blotchside logperch (*Percina burtoni*), logperch *(Percina caprodes*), and Roanoke darter (*Percina roanoka*) (Jones and Neves 2000).

The fanshell has undergone a substantial range reduction. It was historically distributed in the Ohio, Wabash, Cumberland, And Tennessee Rivers and their larger tributaries in Pennsylvania, Ohio, West Virginia, Illinois, Indiana, Kentucky, Tennessee, Alabama, and Virginia (Johnson 1980, KSNPC 1980, Ahlstedt 1986, Bates and Dennis 1985, Lauritsen 1987, Cummings et al. 1987 and 1988, Starnes and Bogan 1988, USFWS 1991). It is believed that reproducing populations are now present in only three rivers, the Clinch River (Hancock County, TN and Scott County, VA), the Green River (Hart and Edmonson Counties, KY), and the Licking River (Kenton, Campbell, and Pendleton Counties, KY). In addition, based on collections of a few older individuals in the 1980s, small remnant (apparently nonreproducing) populations may still persist in the Cumberland River.

The fanshell inhabits medium to large rivers (Bates and Dennis 1985). It has been reported primarily from relatively deep water in gravelly substrate with moderate current (Gordon and Layzer 1989). The loss of many historic populations was likely due to the impacts of impoundments, navigation projects, water quality degradation, and other forms of habitat alteration, including gravel and sand dredging, that directly affected the species and reduced or eliminated its fish host(s) (USFWS 1991). Incidental take of the fanshell where it is co-located with commercially harvested mussel beds is also attributed to its decline (USFWS 1990, 1991).

Most fanshell populations are small and are geographically isolated from one another. It is likely that many of the remaining populations are now small enough that they can no longer maintain long-term genetic viability (Soule 1980). Other current threats to freshwater mussels are well documented in the general mussel description.

4.8.2.2 Effects. Individuals or small populations in the study area may still exist only in the Tennessee River, Kentucky Lake. Although Kentucky Lake is connected to the Cumberland River via an unregulated canal, the possible effects of lowering Center Hill's pool could not reach so far upstream on Kentucky Lake. The proposed action could not, therefore, affect this species.

4.8.2.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the fanshell.

4.8.2.4 Determination. Based on the information above, a No Effect determination has been reached for the Fanshell.

4.8.3 Dromedary Pearlymussel (*Dromus dromas* - Lea, 1834)

4.8.3.1 Species Account Summary. The dromedary pearlymussel is a medium-sized (reaching up to 90 mm in length) freshwater mussel with a yellowish green shell with two sets of broken green rays. The life span of the species is greater than 50 years (USFWS 1984, VFWIS 2003). Like other freshwater mussels, the dromedary pearlymussel feeds by filtering food particles from the water column. The specific food habits of the species are unknown, but other juvenile and adult freshwater mussels have been documented to feed on detritus, diatoms, phytoplankton, and zooplankton (Churchill and Lewis 1924). The diet of dromedary pearlymussel glochidia, like other freshwater mussels, comprises water (until encysted on a fish host) and fish body fluids (once encysted).

The reproductive cycle of the dromedary pearlymussel is similar to that of other native freshwater mussels. Males release sperm into the water column; the sperm are then taken in by the females through their siphons during feeding and respiration. The females retain the fertilized eggs in their gills until the larvae (glochidia) fully develop. The mussel glochidia are released into the water, and within a few days they must attach to the appropriate species of fish, which they parasitize for a short time while they develop into juvenile mussels. The species is bradytictic and glochidia are contained in conglutinates that are similar in appearance to freshwater leeches or flatworms (Jones and Neves 2001). In a recent investigation, a fecundity of approximately 55 to 250,000 glochidia per mussel was estimated for the dromedary pearlymussel by determining the mean number of mature glochidia associated with conglutinates from four females. Ages of valves examined indicate that the species life span is as long as 25 years (Jones and Neves 2001). Recent studies have identified the fantail darter (*Etheostoma flabellare*) as a glochidial host for the dromedary pearlymussel. Laboratory studies also identified the following potential host species: the banded darter (*Etheostoma zonale*), tangerine darter (*Percina aurantiaca*), logperch (*Percina caprodes*), and gilt darter (*Percina evides*) (Watson and Neves 1998). Jones and Neves (2001) recently confirmed the suitability of the banded darter, tangerine darter, and logperch and identified the following additional glochidial host species: black sculpin (*Cottus baileyi*), greenside darter (*Etheostoma blennioides*), snubnose darter (*Etheostoma simoterum*), blotchside logperch (*Percina burtoni*), channel darter (*Percina copelandi*), and Roanoke darter (*Percina roanoka*).

This species was historically widespread in the Cumberland and Tennessee River systems (Bogan and Parmalee 1983). It was last collected from Mussel Shoals, an 85 km reach of the Tennessee River in Alabama, prior to 1931 (van der Schalie 1939) and is presumed to be extirpated from the shoal. The species survives at a few shoals in the Powell and Clinch Rivers in Tennessee and Virginia, and possibly in the Cumberland River in Tennessee (USFWS 1984, Neves 1991). Nine occurrences of the species were recorded during a 1980 survey by Virginia Tech and the Tennessee Valley Authority; however, the dromedary pearlymussel is currently believed to be reduced to only three reproducing populations (NatureServe 2003).

The dromedary pearlymussel inhabits small to medium, low turbidity, high to moderate gradient streams. The species is commonly found near riffles on sand and gravel substrates with stable rubble (USFWS 1984). Though commonly associated with shallow, high velocity riffles and shoals, individuals have been found in deeper (up to 18 feet in depth), slower waters (USFWS 1984).

Many of the historic populations of the dromedary pearlymussel were apparently lost when the river sections they inhabited were impounded. Over 50 impoundments on the Tennessee and Cumberland Rivers have eliminated the majority of riverine habitat for the species in its historic range (ESIS 1996, USFWS 1984). The Powell River and upper tributaries of the Clinch River, in particular, are also subject to sediment and particulate matter loading from coal mining activities (Stansbery 1973). Other threats that are attributed to population declines are similar to those described in the general mussel description.

4.8.3.2 Effects. The dromedary pearlymussel was once found in the Cumberland River system. The current species listing by the Tennessee Natural Heritage Program lists it as possibly still surviving in Davidson, Trousdale, DeKalb, and Smith counties, but the Davidson and Dekalb County records are “historic” (pre-1977). Water quality is a concern for this species. Although the impact from Center Hill as compared to the entire Cumberland River system is minor, if Center Hill does not store and release its customary volumes of water during the summer months, all aquatic species downstream from Center Hill Dam could incur some slight additional stress. This would mimic to some extent what would occur in a natural system during low summer flows. Stressors would primarily be in the form of lowered DO and increased temperatures, but would also include less dilution of pollutants being discharged into the river.

4.8.3.3 Cumulative Affects. The impact of Center Hill on the Cumberland River System in and of itself would be minor. However at the same time Wolf Creek Dam is also undergoing necessary repairs. In the interest of public safety and to relieve pressure on the foundation of Wolf Creek Dam, Lake Cumberland has been lowered. Flows from Wolf Creek Dam are significantly lower than what the public has become accustomed to. Anticipated cumulative affects include significantly changed and reduced water quality for all reaches below Wolf Creek Dam including lower DO, increased water temperatures, and lessened dilution of pollutants. .

4.8.3.4 Determination. Based on the information above, a May Effect determination has been reached for the dromedary pearlymussel.

4.8.4 Cumberlandian Combshell (*Epioblasma brevidens*)

4.8.4.1 Species Account Summary. The Cumberlandian combshell has a thick solid shell with a smooth to cloth-like periostracum, which is yellow to tawny brown in color with narrow green broken rays. The nacre is white. The shells of females are inflated, with serrated teeth-like structures along a portion of the shell margin. See Johnson (1978) and Parmalee and Bogan (1998) for a more complete description of the species and Parmalee and Bogan (1998) for a synonymy of the species. Gordon (1991) provided diagnostic characters.

Spawning in the lampsiline Cumberlandian combshell occurs in late summer (Gordon 1991). Females display until the water temperature drops below approximately 50°F in the fall, burrow into the substrate to overwinter, and begin displaying again as early as March (Jones, pers. comm., 2003). Gravid females, qualitatively estimated at 8 to 13 years of age, have been reported from early May to June at water temperatures of 59.0° to 64.0°F (Ahlstedt 1991a, Yeager and Saylor 1995). The female has a complex mantle display that resembles the cercae of insect larvae (e.g., stoneflies) protruding from under two or three small stones (Jones, pers. comm., 2003). One of its host fishes, the logperch (*Percina caprodes*), has the peculiar habit of flipping small stones in search of food (Etnier and Starnes 1993). Glochidial release generally is complete by mid-June (Jones, pers. comm., 2002). Several other native host fish species have been identified, including the wounded darter, redline darter, bluebreast darter, snubnose darter (*E. simoterum*), greenside darter (*E. blennioides*), banded sculpin, black sculpin, and mottled sculpin (Yeager and Saylor 1995; Jones and Neves, unpub. data). Transformation took from 16 to 48 days, at 60.4° to 62.4°F (Yeager and Saylor 1995).

The Cumberlandian combshell was described from the Cumberland River in Tennessee, possibly from Davidson County (Nashville). Historically, it ranged throughout the Cumberlandian Region, occurring in three physiographic provinces (i.e., Interior Low Plateau, Cumberland Plateau, Ridge and Valley) and five states (i.e., Alabama, Kentucky, Mississippi, Tennessee, Virginia). In the Cumberland River it occurred from the base of Cumberland Falls, McCreary and Whitley Counties, Kentucky, downstream to Stewart County, Tennessee. In the Tennessee River, it occurred throughout the main stem, downstream to Benton and Humphreys Counties, Tennessee. The Cumberlandian combshell also occurred in numerous tributaries in the Cumberland and Tennessee River systems. The most downstream records in both rivers are from archeological sites (Parmalee and Bogan 1998), indicating that at least in premodern times this species occurred further downstream from the area strictly defined as the Cumberlandian Region.

The Cumberlandian combshell has been extirpated from a large percentage of its former range. Mainstem populations in both the Cumberland and Tennessee Rivers are now considered extirpated (Ahlstedt, pers. comm., 2003). This species has also apparently been eliminated from numerous tributaries in the Cumberland River system (e.g., Rockcastle River, Beaver Creek, Obey River, Caney Fork, Stones River, Red River) and the Tennessee River system (e.g., Station Creek, Wallen Creek, Holston River, Nolichucky River, West Prong Little Pigeon River, Little Tennessee River, Paint Rock River, Elk River, Little Bear Creek, Cedar Creek, Duck River). The Cumberlandian combshell has also been extirpated from large portions of additional tributaries in the Cumberlandian

Region (e.g., Clinch River, Powell River, North Fork Holston River, Bear Creek).

Extant Cumberland River system populations occur in Buck Creek, Pulaski County, Kentucky; and Big South Fork, Scott County, Tennessee, and McCreary County, Kentucky (Table 3, USFWS 2003). In the Tennessee River system, populations are thought to remain in the Clinch River, Scott County, Virginia, and Hancock County, Tennessee; Powell River, Lee County, Virginia, and Claiborne and Hancock Counties, Tennessee; and Bear Creek, Colbert County, Alabama, and Tishimingo County, Mississippi (Table 3, USFWS 2003). Although the species was found in Alabama in Cedar Creek (tributary to Bear Creek) in 1988, a recent survey of the entire Bear Creek system failed to reveal even shells of the Cumberlandian combshell at nine sites in Cedar Creek (McGregor and Garner, in press).

The Big South Fork population is sizable and recruiting (Ahlstedt, pers. comm., 2003). Recent evidence of recruitment has also been detected in the Powell River (Jones, letter dated June 9, 2003), but populations in other stream reaches are small and of questionable long-term viability (e.g., Buck Creek, Bear Creek) (Wolcott and Neves 1994, Hagman 2000, McGregor and Garner, in press; Ahlstedt, pers. comm., 2003).

This species inhabits medium-sized streams to large rivers on shoals and riffles in coarse sand, gravel, cobble, and boulders (Dennis 1985, Gordon 1991). It is not associated with small stream habitats (Dennis 1985) and tends not to extend as far upstream in tributaries. In general, it occurs in larger tributaries than does its congener the oyster mussel (*Epioblasma capsaeformis)*. Gordon (1991) states that the species prefers depths less than 3 feet, but it appears to persist in the deep-water areas of the Old Hickory Reservoir on the Cumberland River, where there is still fairly strong flow from the Cordell Hull and Center Hill Reservoirs (Gordon and Layzer 1989).

The abundance and distribution of the Cumberlandian combshell decreased historically from human-induced habitat loss and degradation (Williams et al. 1993, Neves 1993) caused by impoundments (e.g., TVA impoundments on the Cumberland and Tennessee Rivers and their tributaries, Laurel River, Obey River, Caney Fork, Stones River), sedimentation and turbidity, channelization, and contaminants contained in numerous point and nonpoint sources. A comprehensive review of these past threats is provided elsewhere (USFWS 2003, Williams et al. 1993, Neves 1993, Neves 1991, Neves et al. 1997, Watters 2000, Richter et al. 1997). These habitat changes have resulted in significant extirpations (localized loss of populations), restricted and fragmented distributions, and poor recruitment of young. Numerous Cumberlandian Region streams have experienced mussel kills from toxic chemical spills and other causes (Cairns et al. 1971, Crossman et al. 1973, Neves 1986, Wolcott and Neves 1994). The Cumberlandian combshell and its habitat is currently being impacted by excessive sediment bed loads of smaller sediment particles, changes in turbidity, increased suspended solids (primarily resulting from nonpoint-source loading from poor land-use practices and lack of, or maintenance of, best management practices [BMPs], and pesticides (USFWS 2003, Williams et al. 1993, Neves 1993, Neves 1991, Neves et al. 1997, Watters 2000, Richter et al. 1997). Other primarily localized impacts include coal mining, gravel mining, reduced water quality below dams, developmental activities, water withdrawal, impoundments, and alien species. Their restricted ranges and low population levels also increase their vulnerability to toxic chemical spills and the deleterious effects of genetic isolation.

Although the dams of the Cumberland and Tennessee Rivers themselves probably contributed more to the destruction of riverine habitat for the Cumberlandian combshell, channel maintenance activities continue to cause substrate instability and alteration in these rivers and may serve to diminish what habitat remains for the recovery of these species. Impacts associated with coal mining activities have particularly altered upper Cumberland River system streams with diverse historical mussel faunas (Stansbery 1969, Blankenship 1971, Blankenship and Crockett 1972, Starnes and Starnes 1980, Schuster et al. 1989, Anderson et al. 1991) and have been implicated in the decline of *Epioblasma* species, especially in the Big South Fork (Neel and Allen 1964). Strip mining continues to threaten mussels in coal field drainages of the Cumberland Plateau (Anderson 1989, Warren et al. 1999) with increased sedimentation loads and acid mine drainage, including Cumberlandian combshell populations.

4.8.4.2 Effects. The dromedary pearlymussel was once found in the Cumberland River system and appears to persist in the deep-water areas of the Old Hickory Reservoir on the Cumberland River, where there is still fairly strong flow from the Cordell Hull and Center Hill Reservoirs. The species is recorded from Davidson, Trousdale, DeKalb and Smith Counties, but the Davidson and Trousdale records are “historic” (pre-1977). Water quality is a concern for this species. Although the impact from Center Hill as compared to the entire Cumberland River system is minor, if Center Hill does not store and release its customary volumes of water during the summer months, all aquatic species downstream from Center Hill Dam could incur some slight additional stress. This would mimic to some extent what would occur in a natural system during low summer flows. Stressors would primarily be in the form of lowered DO and increased temperatures, but would also include less dilution of pollutants being discharged into the river.

4.8.4.3 Cumulative Affects. The impact of Center Hill on the Cumberland River System in and of itself would be minor. However at the same time Wolf Creek Dam is also undergoing necessary repairs. In the interest of public safety and to relieve pressure on the foundation of Wolf Creek Dam, Lake Cumberland has been lowered. Flows from Wolf Creek Dam are significantly lower than what the public has become accustomed to. Anticipated cumulative affects include significantly changed and reduced water quality for all reaches below Wolf Creek Dam including lower DO, increased water temperatures, and lessened dilution of pollutants.

4.8.4.4 Determination. Based on the information above, a May Effect, but Not Likely to Adversely Affect determination has been reached for the Cumberlandian combshell.

4.8.5 Catspaw or Purple Cat's Paw (*Epioblasma obliquata obliquata*)

4.8.5.1 Species Account Summary. This freshwater mussel historically occurred in the Ohio River and its large tributaries in Ohio, Indiana, Illinois, Kentucky, Tennessee, and Alabama. Presently the purple cat’s paw pearlymussel in known from only two relict, apparently nonreproducing populations—one in a reach of the Cumberland River in Tennessee and one in a reach of the Green River in Kentucky. The distribution and reproductive capacity of this species have been seriously impacted by the construction of impoundments on the large rivers it once inhabited. Unless reproducing populations are found or methods developed to maintain existing populations, this species will likely become extinct in the foreseeable future.

The purple cat’s paw, which is characterized as a large river species (Bates and Dennis 1985), has a medium-size shell that is subquadrate in outline (Bogan and Parmalee 1983). The shell has fine, faint, wavy green rays with a smooth and shiny surface. The inside of the shell is purplish to deep purple (the inside shell of the white cat’s paw is white). Like other freshwater mussels, the purple cat’s paw feeds by filtering food particles from the water. It has a complex reproductive cycle in which the mussel’s larvae parasitize fish. The mussel’s life span, fish species its larvae parasitize, and other aspects of its life history are unknown. The purple cat’s paw pearlymussel was historically distributed in the Ohio, Cumberland, and Tennessee River systems in Ohio, Illinois, Indiana, Kentucky, Tennessee and Alabama (Bogan and Parmalee 1983, Isom, et al. 1979, Kentucky State Nature Preserves Commission 1980, Parmalee et al. 1980, Stansbery 1970, Watters 1986). Based on personal communications with knowledgeable experts (Steven Ahlstedt and John Jenkinson. Tennessee Valley Authority, 1987; Mark Gordon and Robert Anderson. Tennessee Technological University, 1988; Arthur Bogan, Philadelphia Academy of Sciences, 1988; Ronald Cicerello, Kentucky State Nature Preserves Commission, 1988; David Stansbery, Ohio State University, 1987) and a review of current literature, the species is known to survive in only two river reaches, but apparently as nonreproducing populations. These are located in the Cumberland River, Smith County (although also listed in Trousdale and Wilson Counties), Tennessee, and the Green River, Warren and Butler Counties, Kentucky. The continued existence of these two populations is questionable. Unless reproducing populations can be found or methods can be developed to maintain these or create new populations, the species will become extinct in the foreseeable future.

Any individuals that do still survive in these two river reaches are also threatened from other factors. The individuals still surviving in the Cumberland River are potentially threatened by gravel dredging, channel maintenance, and commercial mussel fishing. Although the species is not commercially valuable, incidental take of the species does sometimes occur in the Cumberland River during commercial mussel fishing for other species.

The purple cat's paw pearlymussel was recognized by the Service as a category 2 species (one that is being considered for possible addition to the Federal List of Endangered and Threatened Wildlife) in a May 22, 1984, notice published in the Federal Register (49FR 21664). On May 2, 1988, and September 8, 1988, the Service notified Federal, State, and local governmental agencies and interested individuals by mail that a status review was being conducted specifically on the purple cat's paw pearlymussel and that the species could be proposed for listing. On July 27, 1989, the Service published in the Federal Register (54FR 31209) a proposal to list the purple cat's paw pearlymussel as an endangered species. That proposal provided information on the species' biology, status, and threats to its continued existence.

4.8.5.2 Effects. The only area listed within the study area where the cat's paw may still be extant is in the Cumberland River in Smith County, Tennessee, although if it is still present it does not appear to be reproducing. Water quality is a concern for this species. Although the impact from Center Hill as compared to the entire Cumberland River system is minor, if Center Hill does not store and release its customary volumes of water during the summer months, all aquatic species downstream from Center Hill Dam could incur some slight additional stress. This would mimic to some extent what would occur in a natural system during low summer flows. Stressors would primarily be in the form of lowered DO and increased temperatures, but would also include less dilution of pollutants being discharged into the river.

4.8.5.3 Cumulative Affects. The impact of Center Hill on the Cumberland River System in and of itself would be minor. However at the same time Wolf Creek Dam is also undergoing necessary repairs. In the interest of public safety and to relieve pressure on the foundation of Wolf Creek Dam, Lake Cumberland has been lowered. Flows from Wolf Creek Dam are significantly lower than what the public has become accustomed to. Anticipated cumulative affects include significantly changed and reduced water quality for all reaches below Wolf Creek Dam including lower DO, increased water temperatures, and lessened dilution of pollutants.

4.8.5.4 Determination. Based on the information above, a May Effect, but Not Likely to Adversely Affect determination has been reached for the cat's paw.

4.8.6 Cracking Pearlymussel (*Hemistena lata*)

4.8.6.1 Species Account Summary. Detailed species descriptions can be found in Mirarchi et. al. (2004), Parmalee and Bogan (1998), and USFWS (1991d) therefore only a description summary based on these three references is provided here. The shells of mature Cracking pearlymussels are slightly inflated, thin but fairly strong (Parmalee and Bogan, 1998). The shells are elongated and elliptical to rhomboidal in outline with a rounded anterior margin and pointed to obliquely truncate posterior margin (Mirarchi et. al., 2004). The umbos are flattened and sculptured with a few strong ridges (Parmalee and Bogan, 1998). Shell color ranges from dull yellow, brownish-green, to brown (Parmalee and Bogan, 1998) and dark green broken rays are often found on the shell surface (USFWS, 1991d). The shells do not meet but gape along the anterior and posterior margins and the shell surface may be marked by uneven growth lines (Parmalee and Bogan, 1998). The nacre is pale bluish white with a dark purple umbo cavity and adults can reach up to 90 mm (3.5 inches) in diameter (Parmalee and Bogan, 1998). Cracking Pearlymussels are short-term brooders and glochidia have been observed in mid-May (Parmalee and Bogan, 1998). Jones and Neves (2000) collected females that were gravid from late April to late June and noted that the Whitetail shiner (*Cyprinella galactura*), Streamline chub (*Erimystax dissimilis*), Central stoneroller (*Campostoma anomalum*), and Banded sculpin (*Cottus carolinae*) could be possible hosts for this species.

The Cracking pearlymussel is widely distributed and is more numerous in medium sized rivers (Parmalee and Bogan, 1998). Historically it was found throughout the Ohio, Tennessee, and Cumberland River systems in Ohio, Indiana, Illinois, Kentucky, Tennessee, Alabama, and Virginia (USFWS, 1991d). These mussels are found deeply buried in substrate consisting of mud, sand, and fine gravel and usually occur in medium-sized rivers with moderate currents in less than 2 feet of water (Parmalee and Bogan, 1998). The Cracking pearlymussel was federally listed as and endangered species in 1989 and a recovery plan was written in 1991 (USFWS, 1989b, 1989c, 1991d). To date, critical habitat has not been designated for this species (TVA, 2003). In the Cumberland River watershed, this species was once found in the main stem of the Cumberland River from Clay County, Tennessee upstream to Pulaski County, Kentucky; and in the Big South Fork Cumberland River (Parmalee and Bogan, 1998). The Cracking pearlymussel is considered extirpated throughout much of its range and is thought to exist in a few reaches in the Clinch and Powell Rivers in Tennessee and Virginia, and possibly in the Green River, Kentucky (USFWS, 2001b). The Cracking pearlymussel occurs in Hancock, Lincoln, and Hardin Counties in Tennessee (TABS, 2002d). It survives below Pickwick and Wilson Dams on the Tennessee River, and between Fayetteville, Tennessee and Tims Ford Dam on the Elk River (TVA, 2003). In Alabama the Cracking Pearlymussel is extant only in the Elk River but in few numbers (Mirarchi et. al., 2004). In Kentucky, the Cracking pearlymussel may only exist in the upper Green River (KCWCS, 2005). The USFWS (2001b) plans to establish a nonessential experimental population (NEP) for 16 mussels, including the

Cracking pearlymussel, below Wilson Dam in Colbert County, Alabama. This area is located between Tennessee River miles (TRM 259.4 - 246.0) and includes the lower 5 mile reaches of tributaries entering the Wilson Dam tailwaters (USFWS, 2001b) that, under Section 10(j) of the Endangered Species Act, cannot be designated as critical habitat for a NEP (USFWS, 2001b). The National Park Service (2003) plans to reintroduce the Cracking pearlymussel into the upper Cumberland River system in the Big South Fork National River and Recreational Area in Kentucky and Tennessee. The National Park Service (2003a) also plans to propagate and restore freshwater mussels in a reach of the Green River near Mammoth Cave Nation Park that is inhabited by seven federally endangered mussels including the Cracking pearlymussel.

4.8.6.2 Effects. This species was included in this BA because of its presence in the upper reaches of Kentucky Lake. Although Kentucky Lake is connected to the Cumberland River via an unregulated canal, the possible effects of lowering Center Hill's pool could not reach so far upstream on Kentucky Lake. The proposed action could not, therefore, affect this species.

4.8.6.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Cracking Pearlymussel.

4.8.6.4 Determination. Based on the information above, a No Effect determination has been reached for the Cracking Pearlymussel.

4.8.7 Pink Mucket (*Lampsilis abrupta*)

4.8.7.1 Species Account Summary. Detailed species descriptions can be found in Parmalee and Bogan (1998) Mirarchi et. al. (2004) and the Endangered Species Information System (ESIS, 1996e) therefore only a description summary based on these three references is provided here. The shells of mature Pink muckets are relatively large, thick, heavy, inflated, and subovate to subquadrate in outline (ESIS, 1996e). The umbos are located in the anterior third of the shell and in young individuals they are marked with faint scarcely looped ridges (Parmalee and Bogan, 1998). The posterior shell margin in males is rounded to very bluntly pointed, while female shells are broadly rounded to truncate with values that often gap at the posterior margin especially in females (Mirarchi, et. al., 2004). The posterior ridge is prominent in males and is distinct along the dorsal margin (ESIS, 1996e). The shell surface is smooth and marked by uneven concentric growth lines (ESIS, 1996e). The exterior shell color varies from a light yellow in juveniles, to a yellowish brown or dark brown with occasional markings of broken fine to fairly wide dark green rays (Parmalee and Bogan, 1998). The nacre ranges from white to pink or salmon in color (Mirarchi et. al., 2004). Adults can grow up to 120 mm (4.75 in) in diameter (Parmalee and Bogan, 1998). Pink muckets are long-term brooders (Mirarchi et. al., 2004). Females become gravid in August and contain glochidia in September that are released the following June (Parmalee and Bogan, 1998). According to Mirarchi et. al. (2004), possible host fish for the Pink mucket include Largemouth bass (*Micropterus salmoides*), Smallmouth bass (*Micropterus dolomieu*), Spotted bass (*Micropterus punctulatus*) Sauger (*Stizostedion canadense*) and Freshwater drum (*Aplodinotus grunniens*).

The Pink mucket is a wide ranging Interior Basin species historically inhabiting the Mississippi, Ohio, Cumberland, and Tennessee Rivers (Parmalee and Bogan, 1998) in the states of Louisiana Arkansas, Missouri, Illinois, Indiana Ohio, Pennsylvania, West Virginia, Virginia, Kentucky, Tennessee, and Alabama (USFWS, 1997b). Pink muckets have been found in medium to large rivers, and riverine sections of impoundments (TVA, 2003). They have been collected in habitat ranging from silt to boulders, but the more typical habitat consists of cobble, gravel and sand with individuals found in water depths ranging from 0.8 to 8 m (2.6 – 26.2 feet) deep (ESIS, 1996e). The Pink Mucket was federally listed in 1976 and a recovery plan was written in 1985 (ESIS, 1996e). To date, critical habitat for this species has not been designated (TVA, 2003). According to TVA (2003), the pink mucket has been encountered within the last 30 years in nearly all the tailwaters of the mainstem Tennessee River dams and in parts of Bear Creek and the Clinch, French Broad, and Holston rivers, and although always uncommon or rare, old individuals have been found with a few more individuals found more often below Pickwick and Guntersville Dams. On the Cumberland River, populations tend to be localized with one of the larger populations occurring in the Carthage-Rome area in Smith County, Tennessee (Parmalee and Bogan, 1998). The most recently collected individuals in Tennessee are old adults or relicts of former populations and though the species is widely distributed, it is usually not abundant in the Cumberland and Tennessee Rivers (TABS, 2002h). The Pink mucket only occurs in the riverine reaches below Wilson and Guntersville Dams in Alabama where individuals less than ten years of age are reportedly rare (Mirarchi et. al., 2004). In Kentucky, Pink muckets sporadically occur in the upper Green River (KCWCS, 2005). According to the USFWS (1997b), new Pink mucket populations have been discovered in the Ohio River after an absence of 75 years. The Pink mucket is currently known in 16 rivers and tributaries from seven states (USDOE, 2003). The greatest concentrations are in the Tennessee (Tennessee, Alabama), Cumberland (Tennessee, Kentucky), Osage and Meramec Rivers (Missouri); with smaller numbers found in the Clinch (Tennessee); Green (Kentucky); Ohio (Illinois); Kwanawha (West Virginia); Big Black, Little Black, and Gasconde (Missouri); and Current and Spring Rivers (Arkansas) (USDOE, 2003).

4.8.7.2 Effects. Water quality is a concern for this species. Although the impact from Center Hill as compared to the entire Cumberland River system is minor, if Center Hill does not store and release its customary volumes of water during the summer months, all aquatic species downstream from Center Hill Dam could incur some slight additional stress. This would mimic to some extent what would occur in a natural system during low summer flows. Stressors would primarily be in the form of lowered DO and increased temperatures, but would also include less dilution of pollutants being discharged into the river.

4.8.7.3 Cumulative Affects. The impact of Center Hill on the Cumberland River System in and of itself would be minor. However at the same time Wolf Creek Dam is also undergoing necessary repairs. In the interest of public safety and to relieve pressure on the foundation of Wolf Creek Dam, Lake Cumberland has been lowered. Flows from Wolf Creek Dam are significantly lower than what the public has become accustomed to. Anticipated cumulative affects include significantly changed and reduced water quality for all reaches below Wolf Creek Dam including lower DO, increased water temperatures, and lessened dilution of pollutants.

4.8.7.4 Determination. Based on the information above, a May Effect, but Not Likely to Adversely Affect determination has been reached for the pink mucket.

4.8.8 Ring Pink (*Obovaria retusa* - Lamarck, 1819)

4.8.8.1 Species Account Summary. Detailed species descriptions can be found in Mirarchi et. al. (2004), Parmalee and Bogan (1998), and USFWS (1991e) therefore only a description summary based on these three references is provided here. The shells of mature Ring Pinks (also known as the golf stick pearly mussel) are ovate to subquadrate in outline (USFWS, 1991e). The ventral and posterior shell margins are evenly rounded and the shells are inflated, solid, and thick (Parmalee and Bogan, 1998). The umbos are sculptured with a few weak double-looped ridges and are swollen and turned anteriorly, elevated well above the hinge line (Mirarchi et. al., 2004). The shell surface is marked with noticeable low, irregular, concentric growth lines (Parmalee and Bogan, 1998). The shell exterior lacks rays and the color ranges from yellow-green to brown generally becoming darker brown to black in older individuals (USFWS, 1991e). The nacre ranges from deep purple to salmon to pink surrounded by a white shell border (USFWS, 1991e). Adults can grow to 3.75 inches (95 mm) in diameter (Mirarchi, et. al., 2004). Ring Pinks are long-term brooders and have been found gravid in August and September (Parmalee and Bogan, 1998). To date, no host fish are known for this species (Mirarchi et. al., 2004).

The Ring Pink is an Interior Basin species with a wide range (Parmalee and Bogan, 1998). Historically it was found throughout the Ohio, Tennessee, and Cumberland River systems including major tributaries in the states of Pennsylvania, West Virginia, Ohio, Indiana, Illinois, Kentucky, Tennessee, and Alabama (USFWS, 1991e). The Ring Pink was federally listed as an Endangered species in 1989 and a recover plan was written in 1991 (USFWS, 1989a, 1991e). Ring Pinks are considered big river species however they have been collected in shallow water (approximately 2 feet deep) in habitat typically consisting of sand and gravel (Parmalee and Bogan, 1998). To date, critical habitat has not been designated for this species (TVA, 2003). Since the 1970s, TVA (2003) noted that Ring Pinks were collected only from the Tennessee River below Kentucky and Pickwick dams, the Cumberland River in central Tennessee, the Green River in Kentucky and the Kanawha River in West Virginia. Ring Pinks once inhabited the Cumberland River from Jackson County downstream to Stewart County and in the early 1990s, commercial mussel men collected a couple of relic individuals in Wilson, Trousdale, and Smith Counties in Tennessee (Parmalee and Bogan, 1998). Old relict individuals have recently been collected in the lower Tennessee, Holston, and middle Cumberland Rivers, however, no reproducing populations have been located in recent years (TABS, 2002c). Based on a report from the 1990s individuals may still exist in low numbers below Wilson Dam in Alabama (Mirarchi et. al., 2004). An extant population may exist in the Green River in Kentucky (KCWCS, 2005) The National Park Service (2003a) plans to propagate and restore freshwater mussels in a reach of the Green River near the Mammoth Cave Nation Park that is inhabited by seven federally endangered mussels including the Ring pink.

4.8.8.2 Effects. Individuals or small populations may still exist throughout the study area, particularly in the tailwaters below the dams. Water quality is a concern for this species. Although the impact from Center Hill as compared to the entire Cumberland River system is minor, if Center Hill does not store and release its customary volumes of water during the summer months, all aquatic species downstream from Center Hill Dam could incur some slight additional stress. This would mimic to some extent what would occur in a natural system during low summer flows. Stressors would primarily be in the form of lowered DO and increased temperatures, but would also include less dilution of pollutants being discharged into the river.

4.8.8.3 Cumulative Affects. The impact of Center Hill on the Cumberland River System in and of itself would be minor. However at the same time Wolf Creek Dam is also undergoing necessary repairs. In the interest of public safety and to relieve pressure on the foundation of Wolf Creek Dam, Lake Cumberland has been lowered. Flows from Wolf Creek Dam are significantly lower than what the public has become accustomed to. Anticipated cumulative affects include significantly changed and reduced water quality for all reaches below Wolf Creek Dam including lower DO, increased water temperatures, and lessened dilution of pollutants.

4.8.8.4 Determination. Based on the information above, a May Effect, but Not Likely to Adversely Affect determination has been reached for the ring pink.

4.8.9 Little-wing Pearlymussel (*Pegias fabula*)

4.8.9.1 Species Account Summary. The little-wing pearlymussel is small, not exceeding 1.5 inches (3.8 cm) in length and 0.5 inches (1.3 cm) in width. Like other freshwater mussels, the little-wing pearly mussel feeds by filtering food particles from the water column. The specific food habits of the species are unknown, but other juvenile and adult freshwater mussels have been documented to feed on detritus, diatoms, phytoplankton, and zooplankton (Churchill and Lewis 1924). The diet of little-wing pearly mussel glochidia, like other freshwater mussels, comprises water (until encysted on a fish host) and fish body fluids (once encysted).

The reproductive cycle of the little-wing pearly mussel is similar to that of other native freshwater mussels. Ahlstedt (1986) suggests that the species is a winter or long-term brooder, holding glochidia from midsummer until the following spring. Ahlstedt (1986) reports that the banded sculpin (*Cottus carolinae*) and redline darter (*Etheostoma rufilineatum*) are found in the same habitat as this mussel in parts of its range and may be prime candidates as host species. The greenside darter (*Etheostoma blennioides*) and emerald darter (*Etheostoma baileyi*) have also been identified as glochidial hosts (NCNHP 2003).

This freshwater mussel has been reported historically from 27 river reaches in Alabama, North Carolina, Kentucky, Tennessee, and Virginia. Only a few small populations are known to survive in Horse Lick Creek (Jackson and Rockcastle Counties, KY), Big South Fork Cumberland River (McCreary and Wayne Counties, KY), Little South Fork Cumberland River (McCreary and Wayne Counties, KY), Cane Creek (Van Buren County, TN), North Fork Holston River (Smyth and Washington Counties, VA), Clinch River (Tazewell County, VA), and Little Tennessee River (Swain and Macon Counties, NC) (USFWS 1989, 2003).

The little-wing pearly mussel inhabits small to medium, low turbidity, cool-water, high to moderate gradient streams in the Cumberland and Tennessee River basins (Bogan and Parmalee 1983, Ahlstedt 1986). The species is commonly found near riffles on sand and gravel substrates with scattered cobbles or in sand pockets between rocks, cobbles and boulders (Gordon and Layzer 1989, NatureServe 2003). Individuals have been found lying on top of the substratum, buried in or on top of the substratum in the transition zone between a long pool and riffle, or buried in gravel or beneath boulders and slabrock (Blankenship 1971, Starnes and Starnes 1980, Di Stefano 1984).

The species' decline has resulted primarily from habitat and water quality deterioration caused by impoundments and by pollution and siltation resulting from mining, agriculture, and construction activities. Owing to the species' limited distribution, any factor that adversely modifies habitat or water quality in the short river reaches that the species inhabits could threaten its survival (USFWS 1988).

4.8.9.2 Effects. This species was included as it may be found in Warren County, Tennessee. If it is present it is above the headwaters of Center Hill Lake and would be unaffected by any changes made to Center Hill's pool.

4.8.9.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the little-wing pearlymussel.

4.8.9.4 Determination. Based on the information above, a No Effect determination has been reached for the little-wing pearlymussel.

4.8.10 White Wartyback (*Plethobasus cicatricosus*)

4.8.10.1 Species Account Summary. Detailed species descriptions can be found in Mirarchi et. al. (2004), Parmalee and Bogan (1998), and the Endangered Species Information System (1996b) therefore only a description summary based on these three references is provided here. The shells of white wartyback mussels range from subovate to subtriangular in outline (ESIS, 1996b). The dorsal shell margin is almost straight and the posterior and ventral shell margins are evenly rounded (Parmalee and Bogan, 1998). The posterior ridge is low, narrowly rounded to somewhat flattened, and the umbos are full and elevated well above the hinge line and turn anteriorly (Mirarchi et. al., 2004). The shells are thick, solid, and considerably inflated with uneven concentric growth lines, and a row of low irregular knobs that extend diagonally across the shell surface (Parmalee and Bogan, 1998). The shell surface is cloth-like in texture and rayless (Mirarchi et. al, 2004). Shell color ranges from yellow to greenish yellow in juveniles becoming yellowish brown, in adults (Parmalee and Bogan, 2004). The nacre is silvery white and iridescent posteriorly and adults can reach up to 100 mm (3.9 inches) in diameter (Parmalee and Bogan, 2004). White wartybacks are thought to be short-term brooders that spawn in the spring and release glochidia in the summer (ESIS, 1996b). Fish hosts are unknown; however TVA (2003) notes that the 1984 U.S. Fish and Wildlife Service (1984c) recovery plan suspects that sauger (*Stizostedion canadense*) may be a possible host fish.

The White Wartyback is an Interior Basin species (Parmalee and Bogan, 1998). Populations were once found in the shoals and riffles of the Cumberland, Ohio, Kanawha, Tennessee and Wabash Rivers (TVA, 2003) in the states of Alabama, Illinois, Indiana, Kentucky, Tennessee, and West Virginia (ESIS, 1996b). White Wartybacks have been collected in habitat consisting of a silt-free mixture of gravel and sand (Mirarchi et. al., 2004).

It was historically distributed in the Wabash, Ohio, Kanawha, Cumberland, Holston, and Tennessee Rivers of the Ohio, Cumberland, and Tennessee River systems; however, no live specimens have been recovered from these drainages since the early 1900s (NatureServe 2003). According to Ahlstedt (1984), the white wartyback may still exist in a short reach of the Tennessee River below Pickwick Dam. No living populations have been found in numerous surveys conducted in the Tennessee River since the 1960s; however, fresh dead specimens were collected in 1979 and 1982 below Pickwick Dam near Savannah, Tennessee. If this species still exists, the viability of remaining populations is extremely threatened (NatureServe 2003).

4.8.10.2 Effects. If this species still exists at all it is in the upper end of Kentucky Lake immediately below Pickwick Lock and Dam. All records except for Hardin County, Tennessee are historic (pre-1970). Although Kentucky Lake is connected to the Cumberland River via an unregulated canal, the possible effects of lowering Center Hill's pool could not reach so far upstream on Kentucky Lake. The proposed action could not, therefore, affect this species.

4.8.10.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the white wartyback.

4.8.10.4 Determination. Based on the information above, a No Effect determination has been reached for the white wartyback.

4.8.11 Orange-foot Pimpleback (*Plethobasus cooperianus*)

4.8. 11.1 Species Account Summary. Detailed species descriptions can be found in Mirarchi et. al. (2004), Parmalee and Bogan (1998), and the Endangered Species Information System (ESIS, 1996c), therefore only a description summary based on these three references is provided here. The shells of Orangefoot pimplebacks appear nearly circular or subtriangular in outline (Parmalee and Bogan, 1998). The anterior shell margin is rounded; and the posterior shell margin is obliquely truncate dorsally and rounded ventrally (Mirarchi, et. al., 2004). The shells are solid, heavy, moderately inflated, and marked with concentric, irregular growth lines and contains numerous raised and irregular pustules on the posterior two-thirds (Parmalee and Bogan, 1998) of the shell. The umbos are high, full, and directed forward (Parmalee and Bogan, 1998). Juvenile shells contain many dark green rays that disappear with age (Mirarchi, et. al., 2004). Shell color varies from yellow-brown to a chestnut brown in color and is darker on old individuals (ESIS, 1996c). The umbo cavity is compressed and deep (ESIS, 1996c). The nacre is white to varying shades of pink inside the pallial line (Parmalee and Bogan, 1998). Living specimens have a bright orange colored foot (Mirarchi et. al., 2004). Adults can grow up to 95 mm (3.75 inches) in diameter (ESIS, 1996c). Orangefoot pimplebacks are thought to be short-term brooders that spawn in the spring and release glochidia in the summer (ESIS, 1996c). Females have been found gravid from early June through early August (Mirarchi, et. al., 2004). Fish hosts are unknown (Mirarchi et. al., 2004).

The Orangefoot pimpleback is an Interior Basin species (Parmalee and Bogan, 1998). Historically it was found in parts of the Ohio, Cumberland, Tennessee and Wabash Rivers in the states of Alabama, Indiana, Kentucky, Ohio, Pennsylvania, and Tennessee (ESIS, 1996c). The species was once commonly found in the shoals of medium to large rivers with sand and gravel substrate (ESIS, 1996c). The Orangefoot pimpleback was federally listed in 1976 and a recovery plan was written in 1984 (ESIS, 1996c). To date, critical habitat has not been designated for this species (TVA, 2003). Since the 1970s, it was found in the lower Ohio, middle reach of the Cumberland River, and flowing reaches of the Tennessee River (TVA, 2003). In recent years, a few individuals have been located in the tailwaters of Kentucky, Pickwick, Wilson, Guntersville, Watts Bar, and Fort Loudoun Dams with the most individuals encountered below Pickwick Dam (TVA, 2003). On the Cumberland River, populations were once commonly found from Clay to Stewart Counties, however, in 1980, only a relic population was identified in Smith County, Tennessee on the Cumberland River (Parmalee and Bogan, 1998; TABS, 2002f). Living individuals are now restricted to a few places on the Tennessee River and limited reproduction appears to be taking place in Hardin County, Tennessee (TABS, 2002f), where Mirarchi et. al.(2004) noted the presence of Orangefoot pimplebacks in the tailwaters of Pickwick Dam. In Alabama, the Orangefoot pimpleback has not been reported since 1979 but it may exist in very few numbers below Wilson or Guntersville Dams (Mirarchi et. al., 2004). In Kentucky, (KCWCS, 2005) the Orangefoot pimpleback is sporadically found in the lower Ohio and Tennessee Rivers in western Kentucky. The National Park Service (2003) plans to reintroduce the Orangefoot Pimpleback into the upper Cumberland River system in the Big South Fork National River and Recreational Area in Kentucky and Tennessee.

4.8.11.2 Effects. Individuals or small populations may still exist throughout the study area, particularly in the tailwaters below the dams. Water quality is a concern for this species. Although the impact from Center Hill as compared to the entire Cumberland River system is minor, if Center Hill does not store and release its customary volumes of water during the summer months, all aquatic species downstream from Center Hill Dam could incur some slight additional stress. This would mimic to some extent what would occur in a natural system during low summer flows. Stressors would primarily be in the form of lowered DO and increased temperatures, but would also include less dilution of pollutants being discharged into the river.

4.8.11.3 Cumulative Affects. The impact of Center Hill on the Cumberland River System in and of itself would be minor. However at the same time Wolf Creek Dam is also undergoing necessary repairs. In the interest of public safety and to relieve pressure on the foundation of Wolf Creek Dam, Lake Cumberland has been lowered. Flows from Wolf Creek Dam are significantly lower than what the public has become accustomed to. Anticipated cumulative affects include significantly changed and reduced water quality for all reaches below Wolf Creek Dam including lower DO, increased water temperatures, and lessened dilution of pollutants.

4.8.11.4 Determination. Based on the information above, a May Effect, but Not Likely to Adversely Affect determination has been reached for the orange-foot pimpleback.

4.8.12 Clubshell (*Pleurobema clava*)

4.8.12.1 Species Account Summary. Detailed species descriptions can be found in Parmalee and Bogan (1998), Mirarchi et. al. (2004), and the USFWS (1994) therefore only a description summary based on these three references is provided here. The shells of mature Clubshells are wedge shaped (USFWS, 1994), solid, elongated, and triangular in outline with the umbos full and elevated above the hinge line and often projecting past the anterior margin of the shell (Mirarchi et. al., 2004). Umbo sculpture consists of a few strong, irregular and often broken ridges (Parmalee and Bogan, 1998). A sulcus may be present on older specimens. Shell color ranges from straw-yellow to light brown with distinct dark green rays that may appear as thick blotches or thin lines that are usually interrupted at the growth lines (USFWS, 1994). The nacre is white tending to be iridescent posteriorly particularly in juveniles (USFWS, 1994). Adults can grow up to 65 mm (2.6 in) in diameter (Parmalee and Bogan, 1998). Clubshells are short-term brooders that spawn in the Spring and release glochidia in the late summer of the same year, usually by July or August (USFWS, 1994). Females were found to be gravid from May to July (Mirarchi et. al., 2004). Laboratory studies indicate that potential fish hosts may include Blackside darter (*Percina maculata*), Striped shiner (*Luxilus chrysocephalus*), Logperch (*Percina caprodes*), and Central stoneroller (*Campostoma anomalum*) (TVA, 2003).

The Clubshell is an Interior Basin species (Parmalee and Bogan, 1998). Historically this species was widespread and typically collected within the Ohio River drainage system in Ohio, Indiana, Illinois, and Kentucky, although some populations were present in the Tennessee and Cumberland Rivers (USFWS, 1994). Isolated populations were collected in Michigan, Pennsylvania, and West Virginia (USFWS, 1994). Clubshells are typically found in medium to large rivers in riffle and shoal areas with a gravel and sand substrate, although a few individuals have been found in firm sand and gravel substrate at depths of 4.6 – 5.5 m (15 –18 ft) (Parmalee and Bogan, 1998). The Clubshell was federally listed as Endangered in 1993 and a recovery plan was written in 1994 (USFWS, 1994). To date, critical habitat has not been designated for this species (TVA, 2003). In 1993, the USFWS estimated that the Clubshell's range had been reduced by at least 95% (USFWS, 1994). In 1994, this species was present in small populations in 13 different river segments in Michigan, Indiana, Ohio, Kentucky, West Virginia, and Pennsylvania with the largest viable population was found in the Tippecanoe River in Indiana (USFWS, 1994). It appears to be nearly extirpated in Tennessee with the collection of an occasional relic individual that has survived since impoundment (Parmalee and Bogan, 1998), and it is believed to be extirpated in the mainstem Tennessee River (TVA 2005) except for the nonessential experimental population discussed below. It is extirpated from Alabama (USFWS, 1993, Mirarchi et. al., 2004) and considered extirpated from Illinois (USFWS, 1993). In Kentucky, Clubshells occur sporadically in the upper Green River where populations seem to be recruiting (KCWCS, 2005). According to TVA (2003) live specimens have been reported downstream of Pickwick Dam on the Tennessee River. The USFWS (2001b) plans to establish a nonessential experimental population (NEP) for 16 mussels including the Clubshell, below Wilson Dam in Colbert County, Alabama. This area is located between Tennessee River miles (TRM 259.4 - 246.0) and includes the lower 5 mile reaches of tributaries entering the Wilson Dam tailwaters (USFWS, 2001b) that under Section 10(j) of the Endangered Species Act, cannot be designated as critical habitat for a NEP (USFWS, 2001b). The NPS (2003) plans to reintroduce the Clubshell into the upper Cumberland River system in the Big South Fork National River and Recreational Area in Kentucky and Tennessee. The NPS (2003a) also plans to propagate and restore freshwater mussels in a reach of the Green River near the Mammoth Cave Nation Park that is inhabited by seven federally endangered mussels including the Clubshell.

4.8.12.2 Effects. Although it was once extant on both the Tennessee and Cumberland Rivers, this species appears to have been extirpated throughout the study area. None of the potential impacts of lowering Center Hill's pool could in any way affect this species.

4.8.12.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the clubshell.

4.8.12.4 Determination. Based on the information above, a No Effect determination has been reached for the clubshell.

4.8.13 Cumberland Pigtoe (*Pleurobema gibberum*)

4.8.13.1 Species Account Summary. The Cumberland pigtoe is a small freshwater mussel (rarely exceeding 60 mm in length) with a yellowish-brown shell in juveniles and a dark mahogany brown coloration in adults (USFWS 1991). Like other freshwater mussels, the Cumberland pigtoe feeds by filtering food particles from the water column. The specific food habits of the species are unknown, but other juvenile and adult freshwater mussels have been documented to feed on detritus, diatoms, phytoplankton, and zooplankton (Churchill and Lewis 1924). The diet of Cumberland pigtoe glochidia, like other freshwater mussels, comprises water (until encysted on a fish host) and fish body fluids (once encysted).

The reproductive cycle of the Cumberland pigtoe is similar to that of other native freshwater mussels. In a recent study, Layzer et al. (2003) observed and collected gravid Cumberland pigtoe individuals from late June through August. Anderson (1990) also observed gravid females (with bright red marsupial gills) in mid-July. In laboratory infestation tests, metamorphosis of Cumberland pigtoe glochidia occurred on the telescope shiner (*Notropis telescopus*) and the striped shiner (*Luxilus chrysocephalus*) (Layzer et al. 2003). The telescope shiner is believed to be the primary host for the Cumberland pigtoe given 1) the high frequency of occurrence of glochidia found on this host in the Collins River and 2) observed successful metamorphosis of glochidia from naturally infested telescope shiners collected from the Collins River under laboratory conditions (Layzer et al. 2003).

Based on historic mussel collection records from the Cumberland River system (Anderson 1990, Gordon and Layzer 1989), the Cumberland pigtoe is restricted to the Caney Fork River basin above Great Falls. Within this isolated river basin, the species has been reported from only five Caney Fork River tributaries. However, historic mussel collection records from the upper Caney Fork system are very limited. The species once likely occurred in the main stem of the Caney Fork River, and it was historically collected from Hickory Creek and the Collins River. Anderson (1990) surveyed both areas and found the species in the Collins River but did not collect any specimens at his four sampling stations in the lower Hickory Creek system. However, a population was located in 1992 in the upper portion of Hickory Creek above the area previously searched. Anderson (1990) did not find the species in any unimpounded reaches of the Caney Fork River. It is believed that the species has now been extirpated from the Caney Fork River and lower Hickory Creek.

Presently, the species is restricted to isolated populations in short reaches of five Caney Fork tributaries–Barren Fork (Warren County), Calfkiller River (White County), Cane Creek (Van Buren County), Hickory Creek (Warren County), and Collins River (Warren and Grundy Counties) (Anderson 1990, Widlak 1992). Anderson (1990) also surveyed other Caney Fork tributaries, and he did not find the mussel in Big Creek, Big Hickory Creek (Widlak [1992] later reported a population from this creek), Charles Creek, Dry Branch Barren River, Falling Water River, Firescald Creek, Fultz Creek, Little Hickory Creek, Mountain Creek, Pine Creek, Rocky River, Sink Creek, Smith Fork, Smith Fork Creek, and West

Fork Hickory Creek (USFWS 1992).

The Cumberland pigtoe inhabits small to medium-sized rivers in riffle areas (Gordon and Layzer 1989, NatureServe 2003). This mussel's preferred habitat is riffle areas with sand and gravel with occasional mud and cobble substratum (Anderson 1990, Gordon and Layzer 1989). Anderson (1990) found it inhabiting fast-flowing water in areas with predominately gravel, sand, and cobble substratum. Some sites where the species was collected had beds of macrophitic plants, but the mussel was usually found between, not within, these beds. Water depth ranged from about 10 centimeters to one meter. Anderson (1990) did not find any living specimens in pools or heavily silted areas (USFWS 1992).

The five extant populations are impacted by such factors as impoundments and the general deterioration of water quality resulting from domestic and industrial waste outfalls. Prior to the construction of Rock Island Reservoir in the 1910s, the preferred habitat for this species was more common. Nonpoint pollution sources have limited the distribution of mussels, including the Cumberland pigtoe, in the Caney Fork system. Runoff from surface and deep coal mining operations affects areas of the Collins River, Caney Fork River, Rocky River, and their headwater tributaries. Poor agricultural practices have resulted in soil loss and nutrient enrichment that impact scattered stream reaches throughout the species' range. Construction of bridges, roads, and buildings without adequate siltation control appears to have reduced habitat in sections of the Calfkiller and Collins Rivers. Recent gravel removal operations have destroyed habitat and increased siltation in the upper Caney Fork River and some tributaries. The population in lower Hickory Creek appears to have been lost due to nutrient enrichment and siltation resulting from domestic animal waste (from cows and hogs), as well as from physical habitat alteration caused by allowing animals to have free access to the stream (USFWS 1992).

Given the small size of remaining Cumberland pigtoe populations, any factor that adversely modifies habitat or water quality in the limited reaches where the species is found could threaten its survival in these areas. Also, because the populated reaches are physically isolated from each other by impoundments and unsuitable habitat, recolonization of any extirpated population would be unlikely without human intervention. Additionally, because natural gene flow among populations is no longer possible, the long-term genetic viability of these remaining isolated populations is questionable (USFWS 1992).

4.8.13.2 Effects. Based on historic mussel collection records from the Cumberland River system, the Cumberland pigtoe is restricted to the Caney Fork River basin above Great Falls. It is believed that the species has now been extirpated from the Caney Fork River. As this is above the headwaters of Center Hill Lake, i.e., above the study area, none of the potential impacts of lowering Center Hill's pool could in any way affect this species.

4.8.13.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the Cumberland pigtoe.

4.8.13.4 Determination. Based on the information above, a No Effect determination has been reached for the Cumberland pigtoe.

4.8.14 Rough Pigtoe (*Pleurobema plenum*)

4.8.14.1 Species Account Summary. Detailed species descriptions can be found in Parmalee and Bogan (1998) Mirarchi et. al. (2004) and the Endangered Species Information System (ESIS, 1996d) therefore only a description summary based on these three references is provided here. The shells of mature rough pigtoes are solid, inflated, and subtriangular in outline (Parmalee and Bogan, 1998). The umbos are full, high, turned forward, projecting well above the hinge line and are sculptured with a few irregular nodulous ridges (Parmalee and Bogan, 1998). The posterior ridge is narrowly rounded and ends bluntly; the median ridge is high, wide, and rounded and separated from the posterior ridge by a radial depression (ESIS, 1996d). A shallow sulcus is often present just anterior to the posterior ridge Mirarchi et. al., 2004). The shells are marked with irregular growth lines and are satin-like in appearance (ESIS, 1996d). Shells may be unrayed or marked with a series of fine dark green lines over the posterior half of the shell or umbo that often erodes away with age (Parmalee and Bogan, 1998). Shell color varies from yellowish brown to reddish brown and the nacre is usually white and occasionally pink (Mirarchi et. al., 2004). Adults can grow up to 80 mm (3.1 inches) in diameter (Parmalee and Bogan, 1998). Rough pigtoes are thought to be short-term brooders with females found to be gravid in May (Parmalee and Bogan, 1998). According to the Freshwater Mollusk Conservation Society's Triennial Unionid Report (1998), host fish are unknown, however, possible host fish might be Bluegill (*Lepomis marochirus*), and Rosefin shiner (*Lythrurus ardens*).

Rough pigtoes are Interior Basin species (Parmalee and Bogan, 1998). Historically it was collected within the Ohio, Tennessee, and Cumberland River drainages in Alabama, Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Missouri, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia (ESIS, 1996d). Rough pigtoes were historically found in medium to large rivers with a firmly packed gravel and sand substrate (Parmalee and Bogan, 1998). Specimens have been collected in muddy sand in the Green River and sand in the Clinch River in water depths of 0.8 m (2.6 ft) and 1.0 m (3.3 ft) respectively (ESIS, 1996d). Relic individuals have been collected from water depths ranging between 3.7 – 4.6 m (12 - 15 feet) deep in the Cumberland River in Smith

County, Tennessee (Parmalee and Bogan, 1998). The Rough Pigtoe was federally listed in 1976, and a recovery plan was written in 1984 (ESIS, 1996d). To date, critical habitat has not been designated for this species (TVA, 2003). According to the USFWS (1984b) the Rough pigtoe has been collected from 20 sites in the Green, Barren, Clinch, Tennessee, and Cumberland River systems. On the Cumberland, relic individuals were collected in Smith and Trousdale Counties in Tennessee and on the Tennessee River, upstream Chattanooga, Tennessee (Parmalee and Bogan, 1998). TVA (2003) encountered rough pigtoes in flowing reaches downstream of Pickwick, Wilson, Guntersville, and Watts Bar dams, and in the upstream reaches of Pickwick and Wheeler Reservoirs. In Alabama, rare, extant populations exist below Wilson Dam tailwaters and possibly below Guntersville Dam tailwaters on the Tennessee River (Mirarchi, et. al., 2004). In Kentucky, Rough pigtoes sporadically occur in the Green and Barren Rivers (KCWCS, 2005). In Tennessee, only a few relict specimens exist in remaining mussel beds of the lower Clinch and Holston rivers; and throughout the Tennessee and upper Cumberland Rivers (TABS, 2005f). The National Park Service (NPS) (2003a) plans to propagate and restore freshwater mussels in a reach of the Green River near the Mammoth Cave Nation Park that is inhabited by seven federally endangered mussels including the Rough Pigtoe. The species currently is known to survive downstream of three Tennessee River mainstem dams (Pickwick, Wilson, and Guntersville) and in the Clinch River (between river miles 323 and 154) (NatureServe 2003). In 1984, the rough pigtoe was also reported in the Green River in Kentucky (below locks 4 and 5) and in the Barren River (below lock and dam 1) (USFWS 1984).

4.8.14.2 Effects. Only a few relict specimens may exist throughout the Tennessee and upper Cumberland Rivers. Only historic (pre 1970) records exist on the Cumberland River. Individuals or small populations may still exist in the Tennessee River, Kentucky Lake. Although Kentucky Lake is connected to the Cumberland River via an unregulated canal, the possible effects of lowering Center Hill's pool could not reach so far upstream on Kentucky Lake. The proposed action could not, therefore, affect this species.

4.8.14.3 Cumulative Affects. There are no known future state, tribal, local, or private actions that are reasonably certain to occur in the action area and that would combine with navigation, water supply, recreation, flood damage reduction, hydropower, fish and wildlife, or water quality issues related to lowering the lake level of Center Hill Lake for cumulative effects on the rough pigtoe.

4.8.14.4 Determination. Based on the information above, a No Effect determination has been reached for the rough pigtoe.

5.0 Potential Conservation Measures

These following discretionary measures have been developed for consideration by the U.S. Army Corps of Engineers as actions that could be undertaken by the Nashville District as reasonable and prudent measures.

5.1 Measure No. 1. Installation of an Orifice Gate Over a Sluice Gate. In 2004 the Corps Conducted a study titled *Center Hill Tailwater Modeling for Minimum Flow Evaluation* that found the optimum minimum flow below Center Hill is about 200 cfs. Even a single sluice gate far exceeds this volume (about 1,500 cfs) and it often exceeds the inflow into the lake. To provide minimum flow the Corps has tried pulsing the flows through a single sluice gate with unsatisfactory results. The flow is too much to be sustained and the slope of the river bed rapidly drains the discharged water so that frequent pulsing is required. One solution may be installing an orifice gate over a sluice gate. The orifice gate would limit the discharge to a constant 200 cfs, providing a constant minimum flow with high levels of DO. This would benefit both the tailwater and the upper end of Old Hickory Lake.

5.2 Measure No. 2. Blending Turbine and Sluice Gate Discharges. The average discharge of water from a turbine at Center Hill is between 3,500 and 4,000 cfs depending on the lake level. During the warmer months of the year, i.e., roughly May through October, the water stratifies and virtually all DO in the deeper portions of the lake is consumed by ongoing chemical and biological processes. Consequently, water discharged through the turbines is very low in DO and the tailwater ecology suffers. In recent years the Corps has been experimenting with releases through the sluice gates to compensate for this problem. Water discharged through the sluice gates can have as much as 10 mg/l of DO. Each of the six sluice gates can discharge about 1,500 cfs. Thus, when generation is required during the warmer months a sluice gate can be opened and as the waters from the turbines and the sluices blend adequate DO is achieved. This would benefit both the tailwater and the upper end of Old Hickory Lake.

5.3 Measure No. 3. Supplemental Flows from Other Tributary Lakes. It may be possible to store some excess water in Dale Hollow and/or J. Percy Priest Lakes early in the year and slowly release this water over the summer to mitigate for the reduced flows from Center Hill. This course of action would be dependent on several factors including the amount of rainfall and several operational factors. This was done to a limited extent in 2007 when Dale Hollow was filled to about to about elevation 653, or approximately two feet above the top of the power pool. This action would have to be planned and approved in advance to make any significant difference.

5.4 Measure No 4. Spill vs. Generation. As noted above, the preferred method for regulating lake levels is by hydropower generation. However, during the summer months when water quality in the mainstem lakes typically decreases, the Corps has occasionally resorted to spilling water through the tainter gates rather than by generating because this increases the DO in the tailwater where most of the species of concern are likely to be found. The disadvantage of this, of course, is the power lost by foregoing hydropower generation.

5.5 Measure No. 5. Monitoring. After review of the original iteration of this BA, the USFWS suggested the following potential Conservation Measure. "In addition to the areas along the Caney Fork River that the Nashville District have (sic) agreed to monitor, we request that additional monitoring of temperature, dissolved oxygen, flow, and biological integrity (macroinvertebrates and fish community) occur at Happy Hollow (5 RM below the dam), Stonewall (RM 11 below the dam) and at Carthage. Over the course of the proposed seven-year life of the project , quarterly (seasonal) monitoring at these stations would provide valuable data on potential responses in the tailwater as the zone of cold water in the reservoir diminishes and minimum flows below the dam warm."

The Corps agrees to monitor as proposed by the USFWS, in addition to current water quality monitoring occurring in the Caney Fork River tailwater. The following proposal is offered with requested locations denoted as approximate Caney Fork River Miles (CFM):

- Happy Hollow (CFM 21.3) - Approximately 5 miles downstream of Center Hill Dam
- Stonewall (CFM 11.1) - Approximately 15 miles downstream of Center Hill Dam
- Carthage (CFM 7.3) - Approximately 20 miles downstream of Center Hill Dam.

At these three sites, fish, macroinvertebrates, and water quality data would be collected to assess general community structure and Index of Biological Integrity (IBI) beginning in the spring of 2008 with subsequent collections in the summer, fall, and winter of 2008. How (specific collection methods) and when (specific dates) collections would occur would be coordinated with TVA and the Tennessee Wildlife Resources Agency (TWRA) so as not to interfere with trout stocking. The Corps would develop a sampling plan and share this plan with the participating agencies before the spring collection. Data would be reviewed by the Corps, TVA, TWRA, and USFWS to determine if monitoring should continue as planned, or if alternate sites should be selected, or a different mitigation measure should be considered during the approximate 7-year dam repair period. Additional agencies may be included (such as the Tennessee Department of Environment and Conservation and Environmental Protection Agency) at any time during the monitoring process.

5.5 Measure No. 6. Locate any Temporarily Exposed Cave Openings. During discussions, the U.S. Fish and Wildlife Service expressed the concern that temporary drawdowns would expose cave openings which endangered bats would enter and become trapped or drown as the pool returns to normal. The Corps believes that there is little or no risk of this scenario actually occurring, since the drawdown is not expected to be flat-line and the new lake level curve would somewhat follow the normal schedule with lowest levels in the winter when bats are hibernating. However, to address this concern, the Corps would examine historical maps and cruise the lake perimeter to locate temporarily exposed cave openings. Should any caves be located that are temporarily exposed during the time of year when bats are active, the Corps will confer with the U.S. Fish and Wildlife Service for appropriate action.

6.0 Species/Impact Summary/Conclusions and Determinations

The effects of lowering Center Hill Lake were assessed and found to be limited to changes to water quality. Determination of these potential effects on the species list is summarized in Table 3, below. The analyses of the effects under Corps Nashville District purview in Chapter 4.0, above support an unqualified “no effect” determination for all mammal, bird, insect, reptile, and plant species. Several species of fish and bivalves were also determined to be in the No Effect category. By itself, the action of lowering Center Hill Lake would be unlikely to affect any of the remaining species of concern; however, when considered with other cumulative impacts a determination of May Affect, but Not Likely to Adversely Affect was reached for several species. These species are also identified in Table 3 below.

The Endangered Species Act not only directs that Federal agencies insure that their actions are not likely to jeopardize the continued existence of a listed species or adversely affect its critical habitat, but also directs that they utilize their authorities to further the conservation of listed species. In the spirit of both directives of the Act, the Nashville District proposes a series of conservation measures in Chapter 5, above. Their implementation will not only help to avoid adversely impacting listed species by lowering Center Hill Lake, but proactively further the conservation of these species.

Summary of Effect Determinations

Scientific Name	Common Name	US Status	Class	Impact
Apios priceana	Price's Potato-bean	LT	Magnoliopsida	No Effect
Arabis perstellata	Braun's Rockcress	LE	Magnoliopsida	No Effect
Astragalus bibullatus	Pyne's Ground-plum	LE	Magnoliopsida	No Effect
Charadrius melodus	Piping Plover	LE	Aves	No Effect
Conradina verticillata	Cumberland Rosemary	LT	Magnoliopsida	No Effect
Cumberlandia monodonta	Spectaclecase	C	Bivalvia	May Affect, Not Likely to Adversely Affect
Cyprogenia stegaria	Fanshell	LE	Bivalvia	No Effect
Dalea foliosa	Leafy Prairie-clover	LE	Magnoliopsida	No Effect
Dromus dromas	Dromedary Pearlymussel	LE	Bivalvia	May Affect, Not Likely to Adversely Affect.
Echinacea tennesseensis	Tennessee Coneflower	LE	Magnoliopsida	No Effect
Epioblasma brevidens	Cumberlandian Combshell	LE	Bivalvia	May Affect, Not Likely to Adversely Affect.
Epioblasma obliquata obliquata	Catspaw or Purple Cat's Paw	LE	Bivalvia	May Affect, Not Likely to Adversely Affect.
Etheostoma boschungi	Slackwater Darter	LT	Actinopterygii	No Effect
Etheostoma sp. D	Bluemask (=Jewel) Darter (Doration)	LE	Actinopterygii	No Effect
Hemistena lata	Cracking Pearlymussel	LE	Bivalvia	No Effect
Lampsilis abrupta	Pink Mucket	LE	Bivalvia	May Affect, Not Likely to Adversely Affect.
Lesquerella globosa	Short's Bladderpod	C	Magnoliopsida	No Effect
Lesquerella perforata	Spring Creek Bladderpod	LE	Magnoliopsida	No Effect
Myotis grisescens	Gray Bat	LE	Mammalia	No Effect
Myotis sodalis	Indiana Bat	LE	Mammalia	No Effect
Noturus stanauli	Pygmy Madtom	LE	Actinopterygii	No Effect
Obovaria retusa	Ring Pink	LE	Bivalvia	May Affect, Not Likely to Adversely Affect.
Ophisaurus attenuatus longicaudus	Eastern Slender Glass Lizard	D	Reptilia	No Effect
Orconectes shoupi	Nashville Crayfish	LE	Malacostraca	No Effect
Pegias fabula	Little-wing Pearlymussel	LE	Bivalvia	No Effect
Platanthera integrilabia	White Fringeless Orchid	C	Liliopsida	No Effect
Plethobasus cicatricosus	White Wartyback	LE	Bivalvia	No Effect
Plethobasus cooperianus	Orange-foot Pimpleback	LE	Bivalvia	May Affect, Not Likely to Adversely Affect.
Pleurobema clava	Clubshell	LE	Bivalvia	No Effect
Pleurobema gibberum	Cumberland Pigtoe	LE	Bivalvia	No Effect
Pleurobema plenum	Rough Pigtoe	LE	Bivalvia	No Effect
Pseudanophthalmus colemanensis	A Cave Obligate Beetle	C	Insecta	No Effect
Pseudanophthalmus insularis	Baker Station Cave Beetle	C	Insecta	No Effect
Pseudanophthalmus tiresias	Indian Grave Point Cave Beetle	C	Insecta	No Effect
Sorex longirostris	Southeastern Shrew	D	Mammalia	No Effect
Sterna antillarum athalassos	Interior Least Tern	LE	Aves	No Effect

Table 3

APPENDIX B

CUMBERLAND RIVER BASIN RESERVOIR SYSTEM WATER MANAGEMENT OPERATING PLAN DURING INTERIM POOL RESTRICTIONS AT WOLF CREEK AND CENTER HILL DAMS

Center Hill Lake and Dam
DeKalb County, Tennessee

August 24, 2007
Version 1.2

Cumberland River Basin Reservoir System Water Management Operating Plan During Interim Pool Restrictions at Wolf Creek and Center Hill Dams

Nashville District Corps of Engineers
Nashville, Tennessee

August 2007

Cumberland River Basin
Reservoir System
Water Management Operating Plan
During Interim Pool Restrictions at
Wolf Creek and Center Hill Dams

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Cumberland River Basin Reservoir System Water Management Operating Plan During Interim Pool Restrictions at Wolf Creek and Center Hill Dams

1. Background

1.1. Purpose and Scope. The Corps of Engineers (CE) has implemented interim water control operating restrictions at both Wolf Creek Dam (Lake Cumberland) in Kentucky and Center Hill Dam in Tennessee. Wolf Creek and Center Hill are both experiencing foundation seepage issues that have led the CE to implement a number of risk reduction measures. These pool restrictions are the latest and most significant of these actions. The lower lake levels associated with these actions will reduce the hydrostatic pressure on the foundation and lower the frequency of high lake levels, thus reducing risk at both projects. These interim water control operating restrictions are considered to be dynamic in nature and are subject to modification based on observed conditions. The interim operating restriction at Wolf Creek in 2007 is to operate for a year-round target elevation of 680. Likewise, in 2007 Center Hill has been operated to follow the lower band of the Southeastern Power Administration (SEPA) power marketing zone within the hydropower pool. The operating restrictions at each project will be evaluated periodically as construction progresses. Future lake level restrictions may be more or less stringent than those adopted for 2007. The water management operational guidance outlined in this plan will be in effect until circumstances or data indicate that a different approach is warranted.

1.2. Cumberland River Basin Reservoir System.

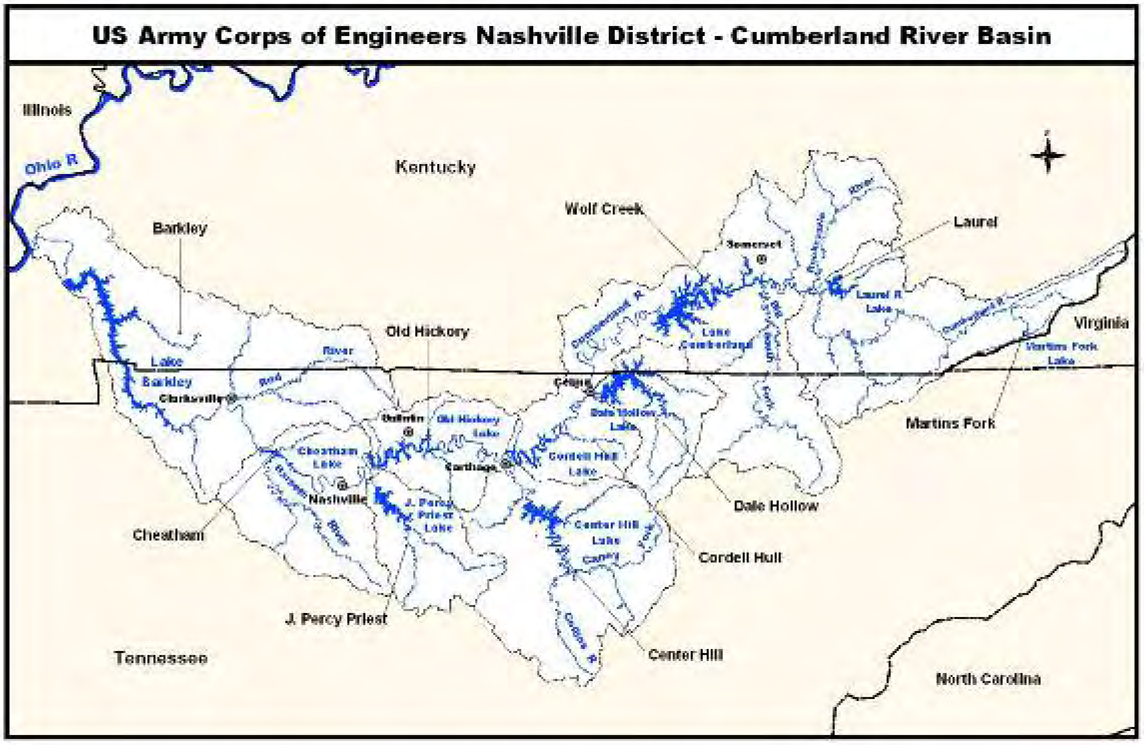
1.2.1. The Cumberland River Basin Master Water Control Plan (dated December 1998) has several general objectives for operation of the system of ten multipurpose water resources projects within the Cumberland River Basin. See Figure 1.

- To provide a significant volume to store flood waters and thereby reduce downstream flood peaks and associated flood damages, particularly at the four damage centers: Celina, Carthage, Nashville, and Clarksville, Tennessee, and also on the lower Ohio and Mississippi Rivers.
- To provide a significant volume to store water for the generation of hydropower at times of peak electrical demand.
- To provide a nine-foot channel depth for commercial navigation from the mouth of the Cumberland River to mile 381 at Celina, Tennessee.
- To provide a series of lake impoundments for the recreational enjoyment of the general public.
- To maintain a minimum reservoir level to offset lake sedimentation, to sustain adequate depths of cover for water supply intakes, to maintain permanent habitat for fish, and to reserve water for severe drought emergencies.

- To provide a sufficient flow of water in the system to enhance water quality for public consumption and aquatic life, and to maintain the availability of water for municipal and industrial users.

Figure 1

Cumberland River Basin Reservoir System



1.2.2. The ability to meet these operating objectives will be challenged by the impacts that these pool restriction requirements will impart on the system. Real-time reservoir system management requires a great deal of judgment in operation. It is recognized that the demands of water resource management are at times conflicting and the water control manager must have some degree of operational flexibility. Depending on the objectives of reservoir operations, the ten multipurpose projects in the Cumberland River Basin can be considered to operate as a unified system, as sub groups of the system, or as individual projects. This plan will outline how project and system operations may be impacted during this period of pool restrictions. The actual system operations will reflect how rainfall, temperature, and other outside influences have altered the water management capabilities of the Cumberland Basin Reservoir System.

1.2.3. The Cumberland River Basin receives an average of 51.64 inches of rainfall per year. Likewise, the average observed runoff generated by this rainfall is 21.82 inches. As noted in Table 1, rainfall and runoff are not evenly distributed over the course of a year.

Table 1

Average Rainfall and Runoff
For the Cumberland River Basin

Month	Rainfall (inches)	Runoff (inches)
January	4.75	3.47
February	4.30	3.43
March	5.75	4.07
April	4.61	2.84
May	4.52	1.87
June	4.18	0.93
July	4.45	0.67
August	3.70	0.47
September	3.75	0.38
October	2.80	0.34
November	4.08	1.07
December	4.75	2.28
TOTAL	51.64	21.82

1.2.4. It is this uneven distribution of runoff that has lead to the current reservoir system operation. Runoff is captured during the late winter and spring in the tributary storage projects (Wolf Creek, Dale Hollow, and Center Hill) and subsequently released during the typically dry summer and fall. Wolf Creek and Center Hill are the two largest storage projects in the Cumberland system. The 2007 pool restrictions will reduce the volume of water in storage by almost two-thirds. Environmental and water resources development within the Cumberland River Basin is dependent on the storage of a large volume of cold water at these projects. Water supply, water quality, fish and wildlife, operation of fossil fuel plants, recreation, and navigation are being impacted by these pool restrictions. The reservoir system will continue to be operated to provide flood control benefits, but the manner in which that is done will also change. Of the ten multipurpose projects within the Cumberland River Basin Reservoir System, Martins Fork will be the only project not impacted by these operating restrictions.

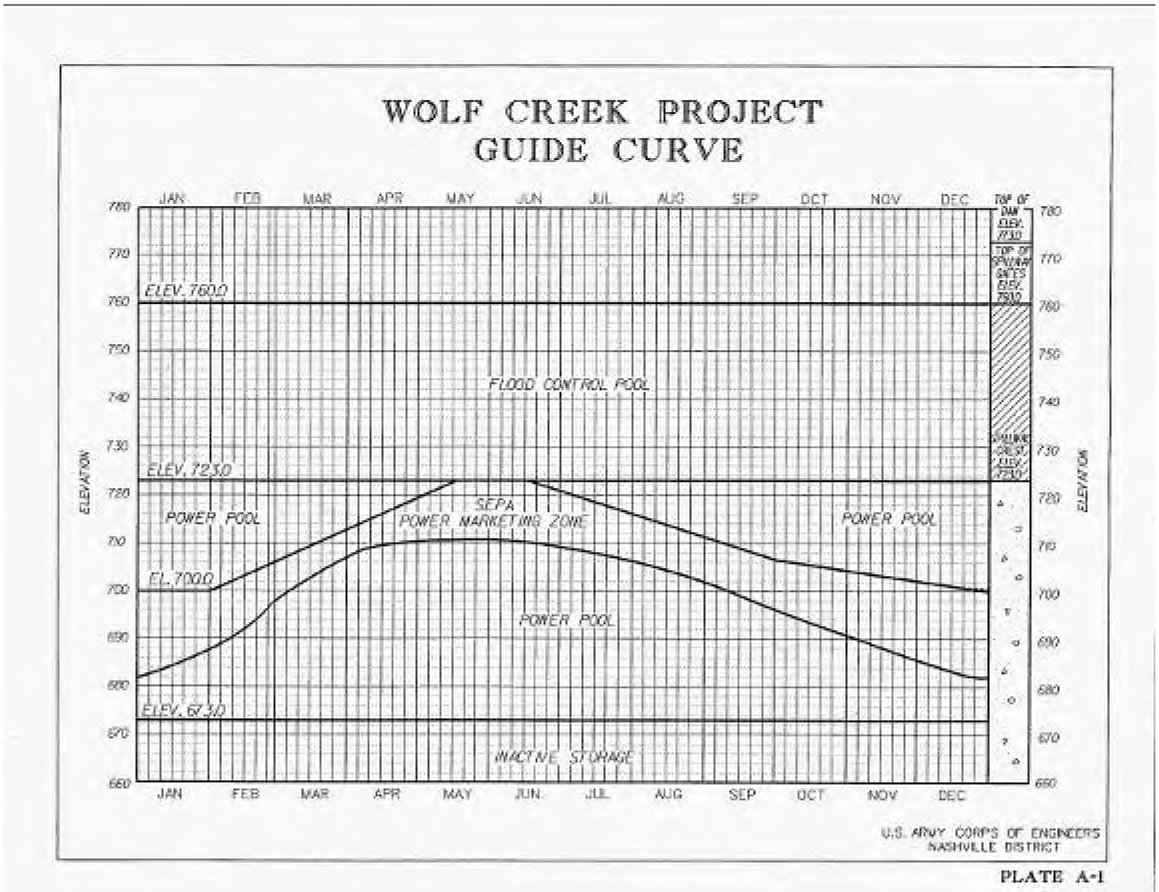
1.3. Wolf Creek.

1.3.1. Wolf Creek Dam was authorized by the Flood Control Act of 1938 and the River and Harbor Act of 1946 to provide flood control and hydropower benefits. Wolf Creek Dam is located on the Cumberland River at mile 460.9. The last of six 45-MW hydropower units was brought on line in August 1952. In addition to its originally authorized project purposes, the Wolf Creek project provides water supply, water quality, recreation, fish and wildlife, and drought mitigation benefits to the region. Wolf Creek has a drainage area of 5,789 mi^2, making it the largest tributary storage project within the Cumberland River Basin System. Lake Cumberland has an average depth of 80 ft and an average discharge of about 9,000 cfs. Wolf Creek is operated as part of the overall

Cumberland River Basin Reservoir System according to an established guide curve. See Figure 2.

Figure 2

Wolf Creek Project Guide Curve



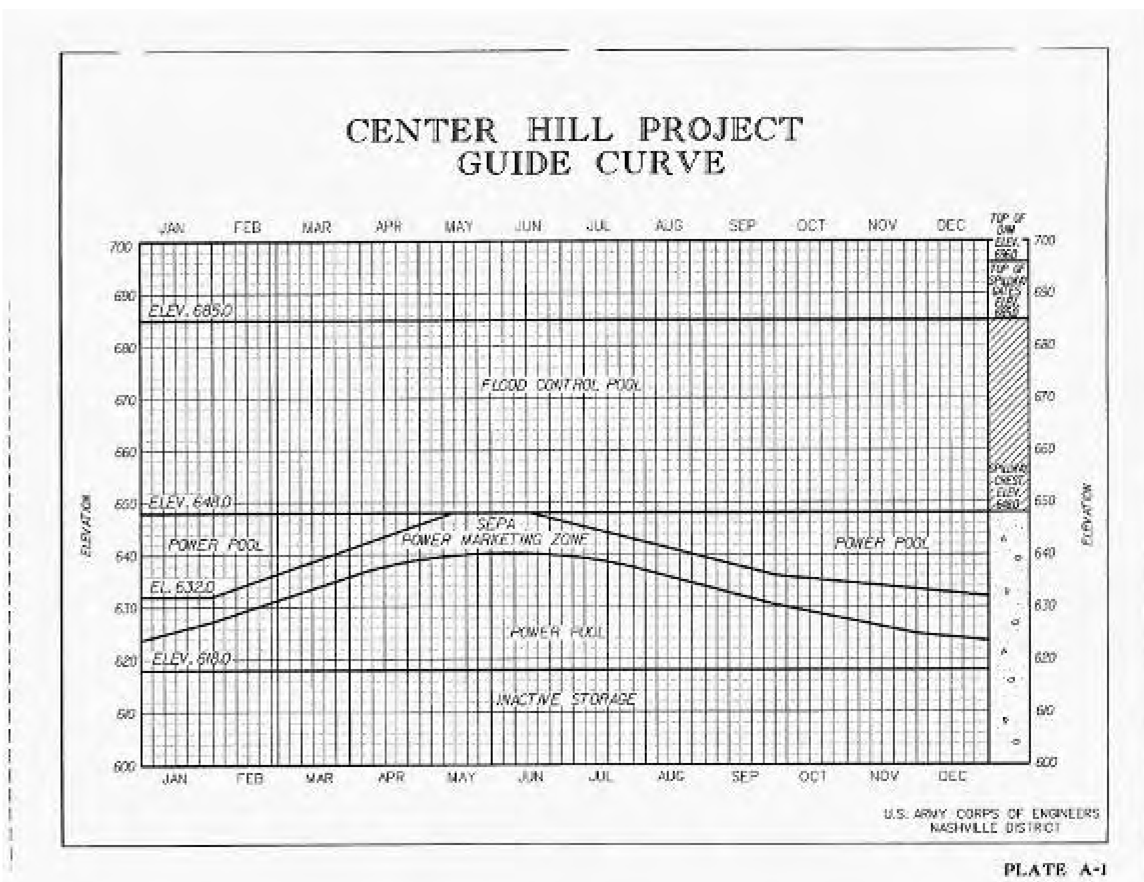
1.3.2. The hydropower pool extends from the top of the conservation pool elevation of 673 ft National Geodetic Vertical Datum (NGVD) of 1929 to elevation 723 ft. The flood control pool extends from 723 ft to 760 ft. The pool of record occurred in May 1984 when the lake reached elevation 751.7 ft. There is a seasonal operating guide within the power pool known as the SEPA power marketing zone. This operating zone was developed by SEPA, working closely with representatives from the Tennessee Valley Authority (TVA) and the CE. The SEPA power marketing zone starts the year low in the power pool, fills through the spring reaching the top of the power pool by summer, and then gradually falls through the summer and fall in time for the flood season. This is a non-binding operating guide that maximizes hydropower benefits while also supporting flood risk management, water quality, navigation, and other downstream uses dependent on the release of stored water through the summer and fall. The normal operation at Wolf Creek is to favor the top of the SEPA power marketing zone, targeting a June 1 elevation of 723 ft. The 2007 risk reduction measure for Wolf Creek Dam is to target a year-round elevation of 680 ft. This operation will reduce the volume of water stored in the hydropower pool by about 1,885,000 acre-feet (88.0%), and will severely impact both project specific and system operations.

1.4. Center Hill.

1.4.1. Center Hill Dam was authorized by the Flood Control Act of 1938 and the River and Harbor Act of 1946 to provide flood control and hydropower benefits. Center Hill Dam is located on the Caney Fork River at mile 26.6. The last of three 45-MW hydropower units was brought on line in April 1951. In addition to its originally authorized project purposes, the Center Hill project provides water supply, water quality, recreation, fish and wildlife, and drought mitigation benefits to the region. Center Hill has a drainage area of 2,174 mi^2, making it second only to Wolf Creek in terms of flood risk management capability. Center Hill Lake has an average depth of 73 ft and an average discharge of about 3,800 cfs. Center Hill is operated as part of the overall Cumberland River Basin Reservoir System according to an established guide curve. See Figure 3.

Figure 3

Center Hill Project Guide Curve



1.4.2. The hydropower pool extends from the top of the conservation pool elevation of 618 ft up to elevation 648 ft. The flood control pool extends from 648 ft up to 685 ft. The pool of record occurred in May 1984 when the lake reached elevation 681.5 ft. Within the power pool, the SEPA power marketing zone starts the year low in the power pool, fills through the spring reaching the top of the power pool by summer, and then gradually falls through the summer and fall in time for the flood season. This is a non-binding operating guide that maximizes hydropower benefits while also supporting flood risk management, water quality, navigation, and other downstream uses dependent on the release of stored water through the summer and fall. The normal operation at Center Hill is to favor the top of the SEPA power marketing zone, targeting a June 1 elevation of 648 ft. The 2007 risk reduction measure for Center Hill Dam is to follow the lower band of this zone, thus targeting a June 1 elevation of 640.6 ft. This operation will reduce the volume of water in storage by about 131,000 acre-feet (26.6%), but will retain some operational flexibility to support project and downstream water management objectives.

1.5. National Environmental Policy Act (NEPA) Considerations.

1.5.1 The CE is preparing Draft Environmental Impact Statements (DEIS) to address operational changes at Wolf Creek Dam and Center Hill Dam. The two DEIS are necessary to provide NEPA compliance to address changes that could include, but are not limited to, water quality, aquatic, riparian, and terrestrial habitat, recreation, water supply, flood storage, economics, hydropower production, and safety as a result of operating Lake Cumberland (Wolf Creek) and Center Hill Lake below normal pool elevations for extended periods of time. NEPA requires that prior to making any decision that would entail any irreversible and irretrievable commitment of resources, a Federal agency shall consult with and obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved, and shall solicit public input and comment. Notices of Intent have been issued for both projects to initiate the NEPA process.

2. System Operations

2.1 Drought Contingency Planning.

2.1.1 The pool restrictions at Wolf Creek and Center Hill have the effect of placing the Cumberland River Basin Reservoir System in a severe hydrologic drought. In fact, flow conditions will be more limited than any seen during operation of the developed reservoir system. From early 1985 through most of 1988, the Cumberland Basin experienced a severe drought; however, even in 1988 during the fourth year of that drought Lake Cumberland was filled to an elevation of 711.77 ft, about 32 ft higher than the 2007 criteria. Likewise, in 1988 Center Hill was filled to elevation 642.34 ft, about two feet above the bottom of the SEPA power marketing zone. The CE applied lessons learned from the 1985-1988 drought to develop an operating policy for drought conditions. The final product of this evaluation was the Cumberland River Basin

Drought Contingency Plan, published in November 1994. Prior to the drought in the 1980s there was not an effective drought contingency plan in place, making system operations during the drought problematic and often contentious. The 1994 drought contingency plan, coupled with recommendations developed in this plan, will form the basis for how the Cumberland River Basin Reservoir System will be operated during these pool restrictions. The established system regulation priorities are as follows.

1. Water Supply
2. Water Quality
3. Navigation
4. Hydropower
5. Recreation

2.1.2. These priorities are consistent with the logic that led to development of the pool restrictions where public health and safety was the overall guiding principle. In fact, dam safety and flood risk management considerations over-ride any other operating objectives. Otherwise, each of the operating objectives will be addressed both individually and from a system perspective. Because the pool restrictions impact the entire Cumberland River system, it will be necessary to have control points to monitor the effectiveness of the system operating plan.

2.2. Control Points. While it is desirable to develop overall water management objectives, it is not practical to apply fixed operating rules. The day to day reservoir system operations will be highly dependent on meteorological conditions, specifically the amount and distribution of rainfall and observed air temperature. System conditions will be evaluated on a daily basis and a forecast will be developed consistent with the overall system operating objectives. The existing precipitation, stream flow, and water quality remote monitoring network is designed for routine system operations. It will be supplemented as necessary to collect the information needed to develop the best possible forecasts. A number of Cumberland River Basin control points have been identified that will serve as overall guides for system operations. The system will be managed for these control points through application of the system priorities contained within the drought contingency plan. It is anticipated that these control points will be dynamic in nature, with one or more factors influencing system operations at any given time. It will remain imperative that water managers retain a reasonable degree of flexibility to be able to react to changing conditions. The Cumberland Basin control points are as follows (presented from upstream to downstream):

- John Sherman Cooper Power Plant
    - Maintain adequate supply of cooling water
- Lake Cumberland municipal and industrial water supply intakes
    - Maintain adequate pool level (680 ft)
- Lake Cumberland cold water budget
    - Protect coldwater fisheries in lake and tailwater
    - Project release objective: 6 mg/l dissolved oxygen
- Wolf Creek National Fish Hatchery

- Provide continuous supply of cold water

- Cumberland County, KY and Burkesville, KY water supply
  - Provide 500 cfs minimum mean daily release from Wolf Creek
- Dale Hollow cold water budget
  - Protect coldwater fisheries in lake and tailwater
- Cordell Hull project releases
  - Project release objective: 5 mg/l dissolved oxygen
  - Schedule releases to support navigation below Cordell Hull
  - Schedule releases to support TVA Gallatin Fossil Fuel Plant
- Center Hill cold water budget
  - Protect coldwater fisheries in lake and tailwater
  - Project release objective: 6 mg/l dissolved oxygen
  - Schedule releases to support TVA Gallatin Fossil Fuel Plant
- TVA Gallatin Fossil Fuel Plant
  - Provide cooling water flow – 1,300 cfs
  - Threshold temperature – 24.4 ^{o}C (76 ^{o}F)
- Old Hickory project releases
  - Project release objective: 5 mg/l dissolved oxygen
  - Schedule releases to support navigation below Old Hickory
- J. Percy Priest project releases
  - Project release objective: 5 mg/l dissolved oxygen
- Cheatham project releases
  - Project release objective: 5 mg/l dissolved oxygen
  - Schedule releases to support navigation below Cheatham
  - Schedule releases to support TVA Cumberland Fossil Fuel Plant
- TVA Cumberland Fossil Fuel Plant
  - Provide cooling water flow – 4,000 cfs
  - Threshold temperature – 29.4 ^{o}C (85 ^{o}F)
- Barkley Canal
  - Manage Canal flows to support TVA Cumberland operations
- Barkley and Kentucky project releases
  - Project release objective: 5 mg/l dissolved oxygen
  - Schedule releases to support navigation below Kentucky and Barkley
  - Ohio & Mississippi River flood risk management operations
  - Ohio & Mississippi River navigation concerns

2.3. Water Supply.

2.3.1. Lake Cumberland Municipal and Industrial Water Supply Users. The system will be operated to maintain a reliable and usable supply of water for both municipal and industrial users as hydrometeorological conditions permit. There are several municipal and industrial water supply users on Lake Cumberland with intakes located between the bottom of the power pool (673 ft) and the 2007 target elevation of 680 ft.

2.3.2. John Sherman Cooper Power Plant. The most vulnerable of these intakes is the one for the John Sherman Cooper Power Plant positioned at elevation 675 ft. This facility, that supplies power to over one million customers in Kentucky, experiences substantial reduction in megawatt production, depending on the water temperature in Lake Cumberland, at elevation 680 ft. Additional derates would be required for lake elevations below 680 ft. Once the lake elevation decreases to 675 ft John Sherman Cooper would be unable to generate power.

2.3.2. Cumberland County, KY and Burkesville, KY Water Supply Intakes. Burkesville, Kentucky and adjacent areas within Cumberland County represent the first concentrated population centers downstream from Wolf Creek Dam. They withdraw water directly from the Cumberland River about 30-40 miles downstream from Wolf Creek Dam. Recently completed HEC-RAS modeling of this reach of the Cumberland River indicates that a minimum mean daily flow of around 500 cfs from Wolf Creek Dam will provide adequate water depth for these intakes. This flow is also supportive of downstream environmental requirements. The minimum mean daily flow from Wolf Creek Dam during normal operating conditions is 1,800 cfs.

2.3.3. A review of the historical record of inflows to Lake Cumberland indicates that flows often get very low during the June through November period. See Table 2. The long term (1953 – 2006) minimum monthly inflow for the months of July, August, September, October, and November are all negative, indicating that evaporation from the lake surface exceeded inflow from the tributary streams. As a result it may be problematic to maintain a 680 elevation in Lake Cumberland during periods of low inflow and high evaporation. Beginning in December, inflows begin to increase significantly due to the increased frequency of rainfall events, making it much easier to meet various operating objectives.

Table 2
Wolf Creek Project Inflow 1953 – 2006

Month	**Minimum (Daily Avg. CFS)**	**Maximum (Daily Avg. CFS)**	**Mean (Daily Avg. CFS)**	**Median (Daily Avg. CFS)**
January	721	41,592	15,409	14,770
February	3,417	50,760	17,798	15,887
March	5,763	54,764	18,989	15,378
April	1,883	34,603	14,683	13,685
May	2,182	37,601	9,368	7,019
June	108	20,730	5,240	3,256
July	-20	16,945	2,916	2,364
August	-182	10,652	1,863	1,127
September	-258	15,212	1,951	630
October	-266	17,780	1,960	1,027
November	-126	20,198	5,831	4,406
December	201	41,922	12,230	11,233

2.3.4. Center Hill Municipal and Industrial Water Supply Users. There are three water supply intakes on Center Hill. They are all located below the bottom of the power pool; therefore, an operational scenario where the target guide curve is to follow the bottom of the SEPA power marketing zone will not impact their operation. The Smith County Utility District has an intake on the Caney Fork River about 19 miles downstream from Center Hill Dam. With the seasonal storage provided by the SEPA power marketing zone there will not be any quantity related issues with this utility. This has been confirmed by HEC-RAS modeling completed for the Caney Fork River. The CE (Center Hill Lake Resource Management) routinely coordinates with staff at the water treatment plant when sluicing operations are initiated at Center Hill so that they can anticipate changes in raw water quality and adjust their treatment accordingly.

2.3.5. Mainstem / Lock and Dam Water Supply Users. There are multiple municipal and industrial water supply intakes along the Cumberland River within the Cordell Hull, Old Hickory, Cheatham, and Barkley pools. There are no plans to lower the headwater operating guidelines for these projects, thus there will be sufficient water available for their continued operation. It is anticipated that there will be changes in the quality of water available for treatment and that treatment costs will go up accordingly. Quality impairments will be a byproduct of reduced flows through the system during the summer and fall. Water users can expect to experience warmer water temperatures, reduced dissolved oxygen levels, increased algal activity with associated taste and odor issues, and increased concentrations of certain metals and nutrients. The reservoir system will be operated to support water quality for water supply to the extent practical given the impacts of the anticipated flow reductions.

2.4. Water Quality.

2.4.1. Water quality impacts may be observed at Wolf Creek and Center Hill as a direct impact of the lower lake levels and/or may occur many miles downstream as a result of release schedule modification. The direct project impacts would be related to changes to the cold water budget.

2.4.2. Water Temperature and Dissolved Oxygen at Wolf Creek. With an operational target of elevation 680 ft (2007 target elevation), Lake Cumberland will begin the summer with a significantly reduced volume of cold water in storage. The coldwater fisheries in the lake, primarily stripers and walleye, are dependent on the maintenance of a zone of cold, oxygenated water. Likewise, the tailwater fishery that includes rainbow and brown trout in addition to striper and walleye is dependent on the release of cold, oxygenated water. If the cumulative project releases through Wolf Creek Dam during the summer exceed the volume of cold water in storage, significant fish die-offs would be expected both in the lake and in the river below the dam. A late spring major storm event or a series of spring or summer storms would increase the likelihood of this happening. The only water management option available for the tailwater at Wolf Creek is to use sluice gate releases in lieu of hydropower releases to provide cold, oxygenated water for the tailwater. Sluicing will conserve the zone of cold water in the lake used by important fish species as long as adequate dissolved oxygen is available. This can be effective up to a point, but once the cold water is gone there is nothing that can be done to protect these fisheries.

2.4.3. Water Temperature and Dissolved Oxygen at Center Hill. Center Hill will face similar cold water budget challenges; however, since the (2007) drawdown there is not as severe as that for Wolf Creek, the risk to these fisheries is less. Sluice gate releases are also a viable option at Center Hill to manage for either lake or tailwater cold water issues.

2.4.4. Water Temperature and Dissolved Oxygen at Dale Hollow. While Dale Hollow does not have any imposed operating restrictions, cold water budget issues could arise due to the increased reliability on water pulled from storage at this project. Dale Hollow also has sluice gates with intakes located deep in the water column that can be used for temperature and/or dissolved oxygen management.

2.4.5. Water Temperature and Dissolved Oxygen at Laurel and J. Percy Priest. The revised operations at Wolf Creek and Center Hill should not have any water quality impacts to either Laurel River Lake or J. Percy Priest Lake. The existing spillway releases for water quality management, pending the availability of water, will continue to be employed at J. Percy Priest as needed for dissolved oxygen, metals, and taste and odor issues observed in the tailwater and at downstream water treatment plants.

2.4.6. Water Temperature and Dissolved Oxygen at Mainstem Projects. Water quality impacts are also expected at the main-stem Cumberland River projects (Cordell Hull, Old Hickory, Cheatham, and Barkley) as a result of the reduced flows moving through the system. The lower flows will increase the hydraulic residence time in each of these projects resulting in warmer water temperatures and lower dissolved oxygen levels. There is little that can be done for temperature since temperature impacts are a direct function of the flow (residence time) through the system and weather conditions. In 2007, with approximately two-thirds of the normal storage eliminated, the summer and fall flow regime will be significantly reduced. The option of releasing water through spillway gates at Cordell Hull, Old Hickory, Cheatham, and Barkley is available to increase dissolved oxygen concentrations. The State Water Quality Standard applicable at each of these projects is a minimum of 5 mg/l.

2.5.6. Based on past experience during drought conditions the Old Hickory project is the most likely main-stem project to experience dissolved oxygen problems. Also, when Lake Cumberland was drawn down in the 1970s for construction of the existing cutoff wall, extremely low dissolved oxygen levels were observed in hydropower releases from Old Hickory.

2.5.7. Prior to 2007, the Nashville District did not have any direct experience of using spillway releases to manage for dissolved oxygen at the main-stem projects. Prior to this year CE reaeration experts at the Waterways Experiment Station indicated that spillway releases are an effective means of aerating project releases. Their recommendation was to spread the flow out over several spillway gates to avoid spilling more than 1,000 cfs through any one gate. CE experience using this release scenario at similar projects has resulted in 85-90% dissolved oxygen saturation and total dissolved gas levels of around 110%. The results to date at projects along the Cumberland River (Cordell Hull, Old Hickory, and Cheatham) have been very favorable. Spillway releases have proven to be an effective method to provide water quality conditions supportive of downstream water treatment and aquatic environment conditions.

2.5.8. TVA operates coal fired power plants at Gallatin and Cumberland City that are dependent on the Cumberland River for cooling water flow. The cooling water for these plants originates in the Cumberland River Basin storage projects (Wolf Creek, Dale Hollow, and Center Hill) during the summer and early fall when natural flows in the Cumberland River are typically very low. Given the elimination of storage at Wolf Creek and the reduction of storage at Center Hill, maintenance of adequate cooling water flow (both quantity and temperature) will become a primary driver for water management operations.

2.5.9. TVA Gallatin Fossil Fuel Plant. The TVA Gallatin Fossil Fuel Plant is located in the Old Hickory pool and is downstream of the three primary storage projects. The cooling water requirement for this facility is 1,300 cfs. The threshold cooling water intake temperature for this facility is 24.4 ^{o}C (76 ^{o}F). The combination of this flow requirement, the physical layout of the intake and discharge structures, and the proximity of the Gallatin plant to upstream cold releases places this facility in a favorable position to maintain reliable service. Water temperature will be the primary concern for this facility.

2.5.10. TVA Cumberland Fossil Fuel Plant. The TVA Cumberland Fossil Fuel Plant, located in the Lake Barkley pool, will be a much bigger challenge with regard to cooling water requirements. Cumberland is significantly larger than Gallatin and has a cooling water requirement of approximately 4,000 cfs and a threshold intake temperature of 29.4 ^{o}C (85 ^{o}F). This plant has a history of cooling water issues during extended hot, dry periods. The plant discharge structure is located close enough to the intake that heated water can recirculate upstream and mix with the Cumberland River flow in the vicinity of the intake. When this occurs the plant must adjust operations to preclude violation of temperature permit requirements. The typical solution for this recirculation issue has been to forego hydropower peaking operations at Cheatham Dam and schedule a steady one unit use throughout the day. This translates to a flow of around 6,300 cfs. However, without the water in storage at the upstream projects there may not be enough water to run a continuous one unit schedule at Cheatham.

2.5.11. A joint TVA/Corps team has been established to work on this issue. TVA has the capability to model temperature impacts to the Lake Barkley project including the immediate TVA Cumberland area. TVA has also made physical modifications to their discharge facility to significantly reduce the amount of heated water from reaching their intake. The cooling water requirements for TVA Cumberland will play an important role in how the Cumberland Basin reservoir system is operated. Water in storage will be conserved to the extent practical during the spring and early summer to save it for use during the critical July, August, and September period. This will be accomplished by only releasing from storage the volume of water necessary to meet flow and temperature requirements at TVA Cumberland.

2.5.12. Wolf Creek and Center Hill will be operated according to the pool restriction criteria. The additional water needed to meet flow requirements will originate from Dale Hollow. This operation could result in higher lake levels than those typically observed in the spring and early summer at Dale Hollow. Likewise, depending on the rainfall pattern fall lake levels at Dale Hollow could be lower than normal.

2.5. Navigation.

2.5.1. A nine-foot commercial navigation channel on the Cumberland River is generally supported by the maintenance of full, flat pools and minimum tailwater elevations at the four main-stem projects. There are navigation impediments in the approaches to both Old Hickory and Cheatham that can effect navigation during low flow conditions. Navigation industry equipment and operations have evolved over time to match observed conditions on the Cumberland River. This includes the decision by some towing companies to run 10-ft draft tugs and to routinely run over-draft (> 9-ft) barges. These practices are due in large part to the water originating from Wolf Creek and Center Hill that augment Cumberland River flows during otherwise low flow periods. Currently, tows are dependent on favorable release schedules to transit reaches below the navigation projects. Their practice is to wait on windows of opportunity to navigate these critical reaches rather than reconfiguring their load to reduce their draft. There will need to be some project release scheduling considerations as well as adjustments by the shipping industry to maintain a reliable commercial navigation pattern during periods of low flow at the navigation projects.

2.5.2. <u>Impacts to Navigation due to Rapid Drawdowns.</u> A rapid drawdown at Wolf Creek and/or Center Hill, followed by severe reductions in discharge, creates abrupt river fluctuations that result in adverse navigation conditions. These adverse conditions extend from the lower approach to Cheatham Lock through the Nashville harbor and into the Old Hickory pool. The lock approaches to Cheatham and Old Hickory along with the main river channel through Nashville are critical areas for commercial navigation. A lower than normal Old Hickory pool elevation has a significant impact to recreational boating, but less of an impact to commercial navigation. Therefore, when lowering Wolf Creek and Center Hill lakes a smooth transition is critical to avoiding navigation impacts downstream.

2.5.3. <u>Impacts to Navigation at Barkley Dam, Kentucky Dam, Ohio River and Mississippi River.</u> Navigation conditions on the Cumberland River at Barkley Lock and Dam and on the lower Ohio River (Lock and Dam 52 and Lock and Dam 53) may be more severely impacted than those upstream along the Cumberland. The Cumberland below Barkley is dependent on either project releases or the Ohio River (Lock and Dam

52 pool) or a combination of both to maintain a minimum tailwater elevation (302) to support navigation. The reduction of storage within the Cumberland system will limit the ability to maintain elevation 302 when Ohio River levels are low. Releases from Barkley and Kentucky are often scheduled to support navigation concerns on the lower Ohio and Mississippi. This capability will be reduced due to the reduction of storage within the Cumberland system and could lead to impaired conditions on the lower Ohio and Mississippi.

2.5.4. The operation of Kentucky and Barkley dams involves complicated and often contradictory issues. Therefore, a predetermined plan to deal with low tailwater levels is not practical. The operational response to navigation conditions when Ohio River levels are low will require coordinated effort between LRD, LRL, LRN, and TVA.

2.6. Hydropower.

2.6.1. Hydropower generated at the Cumberland River Basin plants is marketed by the Southeastern Power Administration (SEPA). In a 1984 Memorandum of Understanding between SEPA, TVA, and the Corps of Engineers minimum weekly energy goals were established. Since that time the CE has an excellent track record of meeting these hydropower goals. See Table 3 for a listing of the minimum energy requirements.

Table 3

Cumberland Basin Projects
Weekly Minimum Energy

Month	Minimum Energy (MWH)
January	24,000
February	29,400
March	32,000
April	32,000
May	22,600
June	24,600
July	32,200
August	32,200
September	21,000
October	15,800
November	16,000
December	20,000

2.6.2. Without the water in storage at Wolf Creek and Center Hill it will not be possible to meet these minimum energy goals. The marketing strategy has been revised to reflect only the energy available for production based on water allocations. Power is now marketed on a daily basis instead of a weekly basis. With the loss of storage due to restrictions at Wolf Creek, the Cumberland River basin will begin each summer at threshold level four of the Cumberland River Basin Drought Contingency Plan. Therefore, the priority for hydropower falls below those for water supply, water quality, and navigation. While a significant amount of the releases at the projects will be through generation, the scheduling will be based on the needs of the higher priority purposes. During periods when the conditions permit, more significance will be given to optimizing for hydropower benefits.

2.6.3. An effort will be made at Laurel River Lake to hold higher summer pool elevations (not to exceed elevation 1018 ft) to support operation of the John Sherman Cooper Power Plant. This will require close coordination with SEPA and the East Kentucky Electric Cooperative.

2.7. Recreation.

2.7.1. The recreation impacts at Lake Cumberland and to a lesser extent Center Hill Lake have been well documented. Lake recreation tends to be elevation dependent. The revised operations at these projects coupled with recreation's priority within the operating objectives established in the drought contingency plan, leaves little in the way of operational flexibility to support recreation interests. The lake level at Laurel can be held higher in the summer without significantly impacting other project purposes including system flood risk management capabilities. This operation would have the added benefit of supporting lake based recreation.

2.7.2. Typical seasonal pool elevations will be maintained at the remaining Cumberland Basin projects. Water control actions implemented for water supply and water quality requirements will have the added benefit of supporting fish and aquatic life based recreational pursuits. Minimum daily project releases will continue to be made from the projects where they are required under the existing operating criteria. The relatively low summer and fall releases from Wolf Creek and Center Hill will enhance wade fishing opportunities in their tailwaters.

2.8. Flood Risk Management.

2.8.1. Even though the Cumberland Basin reservoir system will be operated following drought condition guidelines, the basin is never more than one storm event away from initiating flood risk management operations. Flood risk management will continue to be the over-riding priority for system operations.

2.8.2. Although the lower pools targeted at Wolf Creek and Center Hill will actually increase the flood storage capacity of the system, the operation necessary to consistently maintain these lower levels could compromise the flood risk management benefits of the additional storage capacity. Following a significant runoff producing event, priority will be given to Wolf Creek and Center Hill to evacuate water stored above their target elevations. This presents a couple of issues that have the potential to compromise overall system flood risk management capability. First, if a series of events come in close succession, there is the potential to accumulate water in the other projects to a level that impacts system operation. Second, if a follow up event hits the downstream uncontrolled portion of the basin in conjunction with an aggressive release pattern at Wolf Creek and/or Center Hill to reduce their storage, flood crests could be higher than otherwise experienced. This could occur at any of the Cumberland River damage centers (Celina, Carthage, Nashville, and Clarksville) or along the lower Ohio or Mississippi Rivers. The following tables will be used as a guide on how to evacuate storage at Wolf Creek and Center Hill. Downstream impacts will always be a primary consideration when setting release schedules.

Table 4

Guidelines for Evacuating Storage at
Wolf Creek Dam (Lake Cumberland)

Elevation	Criteria
Wolf Creek:	
0 – 3 ft above upper guide curve elevation	Operate for most efficient use of water.
3 – 5 ft above upper guide curve elevation	Ramp up to turbine capacity as necessary to hold within 5 ft of the upper guide curve elevation if downstream conditions permit.
5 – 10 ft above upper guide curve elevation	Generate at turbine capacity to keep within 5 ft of the upper guide curve elevation. If the pool is forecast to exceed the upper guide curve elevation by more than 10 ft supplement flows with sluice gate releases.
10 ft above upper guide curve elevation up to elevation 723	Combination of turbine capacity and sluice gate releases unless downstream conditions require reductions.
> 723	Combination of turbine, sluice, and spillway releases to manage according to established flood risk management criteria. Total flow not to exceed 40,000 cfs. Full coordination with LRD required if Ohio River flooding is ongoing.

Table 5

Guidelines for Evacuating Storage at
Center Hill Lake

Elevation	Criteria
Center Hill:	
0 – 3 ft above upper guide curve elevation	Operate for most efficient use of water.
3 – 5 ft above upper guide curve elevation	Ramp up to turbine capacity as necessary to hold within 5 ft of the upper guide curve elevation if downstream conditions permit.
5 – 10 ft above upper guide curve elevation	Combination of turbine capacity and sluice gate releases unless downstream conditions require reductions. Discharges should be managed to stay within the downstream channel capacity of 30,000 cfs.
10 ft or more above upper guide curve elevation	Combination of turbine, sluice, and spillway releases to manage according to established flood risk management criteria. Total flow in the Caney Fork River not to exceed 30,000 cfs. Full coordination with LRD required if Ohio River flooding is ongoing.

2.9. Operational Modifications at Cumberland Basin Projects in Addition to Wolf Creek and Center Hill.

2.9.1. The pool restrictions at Wolf Creek and Center Hill have the potential to impact operations at nine of the ten Cumberland Basin Projects. Martins Fork is the only project where no impacts are anticipated. For most of the projects the water control variants are more flow than lake level related; however, there will be a conscious effort to target higher pool elevations at some projects. In all cases where higher headwater elevations are targeted this can be done without significantly compromising system flood risk management capabilities.

2.9.2. Laurel. Laurel has an uncontrolled spillway at elevation 1018.5 ft, and does not provide any flood risk management benefits. The top of the SEPA power marketing curve is at elevation 1018 ft. LRN will work closely with SEPA and the East Kentucky Power Electric Cooperative to target early summer lake levels higher than those typically observed (but not to exceed 1018 ft). The purpose of this operation is to support cooling water operations at the John Sherman Cooper Power Plant during the critical summer and early fall period.

2.9.3. Dale Hollow. The top of the power pool at Dale Hollow is elevation 651 ft. LRN will target a 1 June elevation of 653 ft at Dale Hollow, thus placing two feet of water on the spillway gates and reducing the flood control pool by 15.9 %. This water will be conserved to the extent practical to support downstream water supply, water quality, and navigation requirements along the main-stem Cumberland River projects. Given the ratio of project storage to drainage area, Dale Hollow will be very difficult to overfill under dry conditions (when the extra water would be the most valuable).

2.9.4. Mainstem Lock and Dams. A concerted effort will be made to hold the Cumberland River main-stem projects (Cordell Hull, Old Hickory, Cheatham, and Barkley) near the top to slightly over the top of the stated power pools when possible. The Cumberland River is flashy in nature; a condition that will be amplified due to the run of the river run operations adopted at Wolf Creek. This has the potential to create dramatic (relative to normal operations) swings in elevation along the navigable stretch of the Cumberland River. The maintenance of favorable conditions for commercial navigation is particularly vulnerable to sudden reductions in flow such as those created by operating for a fixed elevation at Wolf Creek. Since the overall dynamics of the main-stem system are difficult to predict under transitional flow regimes, this added water will be used as a buffer when conditions require.

2.9.5. Cordell Hull. The fill to summer pool at Cordell Hull may require additional time and thus needs to begin earlier in order to capture water when available while still passing enough flow to meet downstream requirements. When necessary, the early fill will start at the beginning of April instead of the middle of the month. It may also be necessary to fill Barkley and Kentucky pools early; however, that is a joint decision between LRD, LRN, and TVA since it involves three separate river systems.

3. Communication and Coordination

3.1. Nashville District Water Management. The Nashville District Water Management Office coordinates daily with LRD Water Management, TVA River Operations, SEPA, National Weather Service, LRN Power Plant Operators, and members of the public. Automated data exchange procedures are in place with water management partners and stakeholders. The water management impacts of the revised Wolf Creek and Center Hill operations will require increased communication and coordination efforts in terms of the addition of individuals and groups and also to the frequency of information exchange. The following table summarizes stakeholders, organized by prioritized project purpose, that LRN Water Management has been in contact with since the pool restrictions were announced. This list is considered dynamic in nature and will be supplemented as this process evolves.

Table 6

Water Management Customers
Organized by
Drought Contingency Plan Prioritized Purpose

Agency or Group	Issue
Water Supply:	
Lake Cumberland water supply users	Impacts of lake level on water supply intakes.
Kentucky Division of Water (KDOW)	Water quality impacts to water supply.
City of Burkesville	Low flow impact to raw water intake.
Tennessee Department of Environment and Conservation (TDEC)	Water quality impacts to water supply.
Tennessee Wildlife Resources Agency (TWRA)	Water quality impacts of flow modifications to fish and aquatic resources.
East Kentucky Power Cooperative (EKPC)	Cooling water at John Sherman Cooper Power Plant.
TVA Fossil Fuel Plants	Cooling water at Gallatin and Cumberland.
TVA Environmental Compliance	Cooling water at Gallatin and Cumberland.
Metro Nashville	Water quality impacts to water supply.
Water Quality:	
Kentucky Department of Fish and Wildlife Resources (KDFWR)	Impacts to the coldwater budget in Lake Cumberland and the river below.
Kentucky Division of Water (KDOW)	Impacts to the coldwater budget in Lake Cumberland and the river below.
U. S. Fish & Wildlife Wolf Creek National Fish Hatchery (USFWS)	Supply of cold water to the Wolf Creek National Fish Hatchery.
Tennessee Department of Environment and Conservation (TDEC)	Impacts to the Cumberland River impoundments in Tennessee.
Tennessee Wildlife Resources Agency (TWRA)	Fishery impacts at Center Hill and Cumberland River projects and impacts to native mussels in Cumberland River.
Metro Nashville	Impacts of water quality changes to wastewater treatment plant operations.
Trout Unlimited (TU)	Impacts to cold water fisheries.
Ohio Valley Fly Rod Club	Impacts to cold water fisheries.
Navigation:	
U. S. Coast Guard	Impacts to commercial navigation resulting

	from reduced flows in the system.
Navigation Industry	Impacts to commercial navigation resulting from reduced flows in the system.
Hydropower:	
Southeastern Power Administration (SEPA)	Impacts to power marketing agreements.
TVA River Operations	Impact of revised system operations on hydropower production.
TVA Power Scheduling	Hourly scheduling of hydropower.
East Kentucky Power Cooperative (EKPC)	Hydropower scheduling at Laurel River Lake.
Team Cumberland	Impact of revised system operations on hydropower production.
Recreation:	
Kentucky Department of Fish and Wildlife Resources (KDFWR)	Impact of Wolf Creek drawdown on fishing and boating opportunities.
Tennessee Wildlife Resources Agency (TWRA)	Impact of Wolf Creek and Center Hill drawdowns on fishing and boating opportunities.
Marina Operators	Impact of lake level revisions on marina operations.
Trout Unlimited (TU)	Impacts to cold water fisheries.
Ohio Valley Fly Rod Club	Impacts to cold water fisheries.
Middle Tennessee Amateur Retriever Club	Impact of pool restrictions on system operations.
Commercial Fishermen	Impact of pool restrictions on system operations.

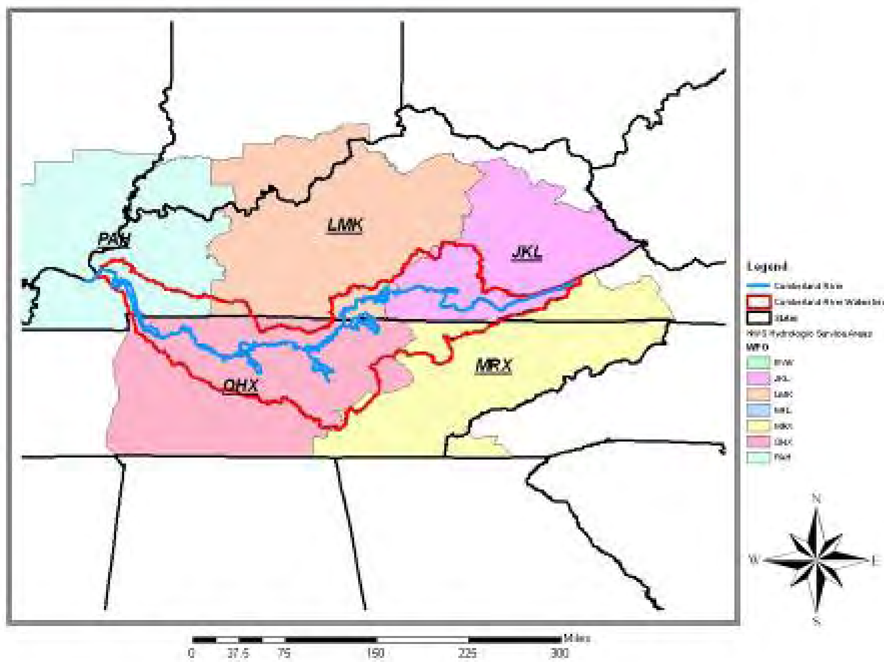
3.2. National Weather Service Coordination.

3.2.1. CE partners closely with the National Weather Service (NWS) and provides the agency with daily river and reservoir observations (flow and stage) and reservoir release schedules. The observations and reservoir release schedules are integral to the production of the NWS hydrologic forecasts. This information is transmitted daily from the Nashville District (and the other Ohio River District offices) in automated SHEF-encoded reports to the Division office (LRD) located in Cincinnati, Ohio. Data is then exchanged with the NWS Ohio River Forecast Center (OHRFC) in Wilmington, Ohio via a dedicated communication line.

3.2.2. The OHRFC has the primary responsibility for producing and disseminating stage and flow forecasts of the Ohio River and its tributaries. The OHRFC provides the forecasts to local Weather Forecast Offices by hydrologic service area

(HSA) for the issuance of flood watches and warnings to the public. Four HSAs primarily encompass the Cumberland River System. The service areas and river system are shown in Figure 4.

Figure 4
National Weather Service
Hydrologic Service Areas



3.2.3. During flood events on the lower Ohio and Mississippi Rivers, LRD communicates closely with the OHRFC and two other RFCs, the Lower Mississippi River Forecast Center (LMRFC) and the North Central River Forecast Center (NCRFC). The junction point for this delineation is located at Dover, TN, approximately Cumberland River Mile 89. Under Section 7 of the Flood Control Act of 1944, LRD directs the operations of Nashville District's Lake Barkley, and the Tennessee Valley Authority's Kentucky Lake, to reduce flood crests with the primary objective of preserving and protecting the Mississippi River levee system. LRD communicates closely with the RFCs in the production of the public river forecasts.

3.2.4. During the interim period, established data flow and communication procedures will continue. However, if the Wolf Creek release schedule should significantly change after the normal transmission time to LRD, the reservoir scheduler should inform LRD Water Management. If LRD cannot be reached, the Ohio River Forecast Center should be contacted directly. See Table 6 below for information for the various water control centers associated with Cumberland River Basin system operations.

Table 7

Water Control Centers

Office	Office Phone and Hours	Non-Duty Phone
LRD Water Management	(###) ###-#### 7:00 a.m. – 4:00 p.m.	(###) ###-####
LRN Water Management	(###) ###-#### 7:30 a.m. – 4:00 p.m.	(###) ###-####
TVA River Operations	(###) ###-#### 24-hour operation	(###) ###-####
Ohio River Forecast Center	(###) ###-#### 6:00 a.m. – 10:00 p.m.	(###) ###-####
Lower Mississippi River Forecast Center	(###) ###-#### 6:00 a.m. – 10:00 p.m.	

3.2.5. During flooding on the Cumberland System, LRN Water Management should maintain close contact with LRD Water Management, the NWS Ohio River Forecast Center, and the NWS Service Hydrologists for the four HSAs to keep all informed as to the flood control strategy. Should the strategy significantly change during the day invalidating the NWS publicly issued forecasts, LRN Water Management should notify the Service Hydrologists in addition to LRD and the OHRFC. NWS contact information is presented in Table 7.

Table 8

Contact Information for the
National Weather Service

Hydrologic Service Area	Service Hydrologist or Focal Point	Office Phone	Operations Desk Phone (24 x7)
LMK	**********, Louisville, KY WFO	(###) ###-####	(###) ###-####
JKL	********** Jackson, KY WFO	(###) ###-####	(###) ###-####
OHX	********** Nashville, TN WFO	(###) ###-####	(###) ###-####
PAH	********** Paducah, KY WFO	(###) ###-####	(###) ###-####
LCH	********** Slidell, LA WFO	(###) ###-####	(###) ###-####

3.2.6. When a lower Ohio flood control operation is in effect, decisions regarding Wolf Creek releases and other Cumberland System reservoirs must be coordinated with LRD Water Management to ensure that all system regulation objectives are met to the extent possible. This coordination must take place before Wolf Creek release decisions are effected, unless under conditions of imminent dam failure. This coordination should occur during the regularly scheduled flood coordination call at 8:30 a.m. Eastern time (7:30 a.m. Central) between LRD and LRN. In the event of an imminent dam failure, communication procedures as specified in the Wolf Creek Dam Emergency Operations plan are followed. A multi-agency phone list is presented in Table 9.

Table 9

Water Management Phone List

Position	Name	Office	Home
LRN Water Management:			
Chief, H&H Branch	**********	(###) ###-####	(###) ###-####
Chief, Water Management	**********	(###) ###-####	(###) ###-####
Senior Forecaster	**********	(###) ###-####	(###) ###-####
Senior Forecaster	**********	(###) ###-####	(###) ###-####
Data Management	**********	(###) ###-####	(###) ###-####
Data Management	**********	(###) ###-####	(###) ###-####
Modeler	**********	(###) ###-####	(###) ###-####
Modeler	**********	(###) ###-####	(###) ###-####
Stream Gauging	**********	(###) ###-####	(###) ###-####
Biologist	**********	(###) ###-####	(###) ###-####
Chemist	**********	(###) ###-####	(###) ###-####
LRN Offices:			
District Engineer	**********	(###) ###-####	
LRN DPM	**********	(###) ###-####	
OC – Chief	**********	(###) ###-####	
OC - Environmental	**********	(###) ###-####	
NEPA Coordination	**********	(###) ###-####	
Chief, EC Division	**********	(###) ###-####	
Chief, Civil Design Branch	**********	(###) ###-####	
Dam Safety Coordinator	**********	(###) ###-####	
Chief, Operations Division	**********	(###) ###-####	
Chief, Hydropower Branch	**********	(###) ###-####	
Chief, Navigation Branch	**********	(###) ###-####	
Chief, Natural Resources	**********	(###) ###-####	
WOL Project Manager	**********	(###) ###-####	
CEN Project Manager	**********	(###) ###-####	
Chief, Public Affairs	**********	(###) ###-####	
East Kentucky OM	**********	(###) ###-####	
EKY Power Plant Manager	**********	(###) ###-####	
WOL/P Superintendent	**********	(###) ###-####	
WOL/P Control Room	**********	(###) ###-####	
WOL/R Resource Manager	**********	(###) ###-####	
LAU/P Superintendent	**********	(###) ###-####	
LAU/R Resource Manager	**********	(###) ###-####	
Mid Cumberland OM	**********	(###) ###-####	
MCA Power Plant Manager	**********	(###) ###-####	
DAL/P Superintendent	**********	(###) ###-####	

DAL/P Control Room	**********	(###) ###-####	
DAL/R Resource Manager	**********	(###) ###-####	
COR/P Superintendent	**********	(###) ###-####	
COR/P Control Room	**********	(###) ###-####	
COR/L Lock Master	**********	(###) ###-####	
COR/R Resource Manager	**********	(###) ###-####	
CEN/P Superintendent	**********	(###) ###-####	
CEN/R Resource Manager	**********	(###) ###-####	
Nashville Area OM	**********	(###) ###-####	
NAS Power Plant Manager	**********	(###) ###-####	
OLD/P Superintendent	**********	(###) ###-####	
OLD/P Control Room	**********	(###) ###-####	
OLD/L Lock Master	**********	(###) ###-####	
OLD/R Resource Manager	**********	(###) ###-####	
JPP/R Resource Manager	**********	(###) ###-####	
CHE/P Superintendent	**********	(###) ###-####	
CHE/L Lock Master	**********	(###) ###-####	
CHE/R Resource Manager	**********	(###) ###-####	
West Kentucky OM	**********	(###) ###-####	
WKY Power Plant Manager	**********	(###) ###-####	
BAR/P Superintendent	**********	(###) ###-####	
BAR/P Control Room	**********	(###) ###-####	
BAR/L Lock Master	**********	(###) ###-####	
BAR/R Resource Manager	**********	(###) ###-####	
KY Lock Resident Engineer	**********	(###) ###-####	
KY Lock Field Office	**********	(###) ###-####	
KY/L Lock Master	**********	(###) ###-####	
WOL Resident Engineer	**********	(###) ###-####	
WOL Field Office	**********	(###) ###-####	
CEN Resident Engineer	**********	(###) ###-####	
CEN Field Office	**********	(###) ###-####	
LRD Offices:			
Division Engineer	**********	(###) ###-####	
Deputy Division Engineer	**********	(###) ###-####	
Chief, Water Management	**********	(###) ###-####	(###) ###-####
Senior Hydraulic Engineer	**********	(###) ###-####	(###) ###-####
Regional WCDS Manager	**********	(###) ###-####	(###) ###-####
Hydraulic Engineer	**********	(###) ###-####	
Hydraulic Engineer	**********	(###) ###-####	
IM Specialist	**********	(###) ###-####	
OC – NEPA	**********	(###) ###-####	
Dam Safety Coordinator	**********	(###) ###-####	
Environmental Business Line	**********	(###) ###-####	

HQ Offices:			
H&H COP	**********	(###) ###-####	
Water Quality	**********	(###) ###-####	
LRD RIT	**********	(###) ###-####	
HQ UOC	**********	(###) ###-####	
TVA Offices:			
Knoxville:			
Manager River Forecasting	**********	(###) ###-####	
Lead Engineer Assignment	**********	(###) ###-####	
Preschedule Assignment	**********	(###) ###-####	
Hydrothermal Modeling	**********	(###) ###-####	
Navigation	**********	(###) ###-####	
Chattanooga:			
Daily Scheduling	**********	(###) ###-####	
Environmental Compliance	**********	(###) ###-####	
Gallatin Fossil Plant:			
Plant Manager	**********	(###) ###-####	
Navigation/Coal Handling	**********	(###) ###-####	
Engineering Manager	**********	(###) ###-####	
Cumberland Fossil Plant:			
Environmental Specialist	**********	(###) ###-####	
Engineering Manager	**********	(###) ###-####	
Plant Operations	**********	(###) ###-####	
National Weather Service			
ORFC Service Hydrologist	**********	(###) ###-####	
LMK Service Hydrologist	**********	(###) ###-####	
JKL Service Hydrologist	**********	(###) ###-####	
OHX Service Hydrologist	**********	(###) ###-####	
PAH Service Hydrologist	**********	(###) ###-####	
Power:			
SEPA Hourly Scheduling	**********	(###) ###-####	
SEPA System Operations	**********	(###) ###-####	
SEPA Operations Center	**********	(###) ###-####	
Sherman Cooper Power	**********	(###) ###-####	
Navigation:			
Coast Guard – Paducah	**********	(###) ###-####	
Coast Guard – Nashville	**********	(###) ###-####	
LRL–Chief, Operations	**********	(###) ###-####	
LRL–Chief, Tech Support	**********	(###) ###-####	
LRL-Chief, Maintenance	**********	(###) ###-####	
LRL-L/D 52 Project Manager	**********	(###) ###-####	

LRL-Operations Manager	**********	(###) ###-####	
Smithland Lock Master	**********	(###) ###-####	
L&D 52 Lock Master	**********	(###) ###-####	
L&D 53 Lock Master	**********	(###) ###-####	
Water Quality:			
USFWS (Cookeville)	**********	(###) ###-####	
KDOW – Technical Manager	**********	(###) ###-####	
KDOW – Water Sampling	**********	(###) ###-####	
KDFWR – Water Quality	**********	(###) ###-####	
TDEC – Technical Manager	**********	(###) ###-####	
TDEC – Permits	**********	(###) ###-####	
TWRA – Technical Manager	**********	(###) ###-####	
Fish & Wildlife:			
USFWS – Regional Manager	**********	(###) ###-####	
USFWS – WOL Hatchery	**********	(###) ###-####	
USFWS – DAL Hatchery	**********	(###) ###-####	
KDFWR – Fisheries Director	**********	(###) ###-####	
KDFWR – Trout Coordinator	**********	(###) ###-####	
KDFWR – Regional Biologist	**********	(###) ###-####	
TWRA – Fisheries Director	**********	(###) ###-####	
TWRA – Trout Coordinator	**********	(###) ###-####	
TWRA – Regional Biologist	**********	(###) ###-####	

3.3. Decision Making Protocol. The intended purpose of this interim operating plan is to identify potential water management conflicts and outline how the Cumberland River Basin reservoir system would be operated to best address these issues. It is not reasonable to expect, given the inherent uncertainty associated with weather and related hydrologic conditions, that specific water control decisions can be made well in advance. Rather, this plan will provide LRN Water Management with an approved operational guide from which day to day water control decisions can be made. When water becomes short and water management actions become particularly contentious it may become necessary to elevate certain decisions. This will be done through application of existing protocol where established chain of command is followed. The nature of water management is that decisions have to be made quickly. There simply isn't the luxury of time in many scenarios. Whenever LRN Water Management recognizes or otherwise is made aware of the sensitive nature of certain water control actions they will concurrently raise the issue to LRN Senior Staff and LRD Water Management (for coordination with LRD Senior Staff) for resolution. LRN Water Management will serve in an advisory, information providing role to support the decision making process. Once the decision is made LRN Water Management will be tasked with its implementation and subsequent tracking and evaluation.

4. References

Cumberland River Basin Master Water Control Reference Manual. U.S. Army Corps of Engineers Nashville District. Nashville, 1990.

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Cumberland River Basin Barkley Water Control Manual. U.S. Army Corps of Engineers Nashville District. Nashville, 1998.

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Cumberland River Basin Cordell Hull Water Control Manual. U.S. Army Corps of Engineers Nashville District. Nashville, 1998.

Cumberland River Basin J. Percy Priest Water Control Manual. U.S. Army Corps of Engineers Nashville District. Nashville, 1998.

Cumberland River Basin Center Hill Water Control Manual. U.S. Army Corps of Engineers Nashville District. Nashville, 1998.

Cumberland River Basin Dale Hollow Water Control Manual. U.S. Army Corps of Engineers Nashville District. Nashville, 1998.

Cumberland River Basin Wolf Creek Water Control Manual. U.S. Army Corps of Engineers Nashville District. Nashville, 1998.

Cumberland River Basin Laurel Water Control Manual. U.S. Army Corps of Engineers Nashville District. Nashville, 1998.

Cumberland River Basin Drought Contingency Plan. U.S. Army Corps of Engineers Nashville District. Nashville, 1994.

Memorandum of Understanding (Operating Agreement) Between Corps of Engineers, U.S. Army, Tennessee Valley Authority, and Southeastern Power Administration, Department of Energy, With Respect to Operations of the Cumberland System Projects. 1984.

Amended and Restated Agreement executed by The United States of America Department of Energy acting through the Southeastern Power Administration and Tennessee Valley Authority and Tennessee Valley Public Power Association. 1997.

APPENDIX C

RESPONSES TO NOTICES, SCOPING, AND DRAFT ENVIRONMENTAL IMPACT STATEMENT

Center Hill Lake and Dam
DeKalb County, Tennessee

COORDINATION

Public and Agency Comments.

For the last two years the Corps has conducted public meetings, and has meet with federal, state, local, public and private agencies regarding the seepage problems at Wolf Creek and Center Hill Dams. Websites for these projects were created at that time on the Corps' website, under "Hot Topics" at: http://www.lrn.usace.army.mil/. For their situational awareness, the citizens of Tennessee and Kentucky were informed of the seepage problems, potential for dam failure, emergency action planning, modified pool elevations, repair options and schedule at these projects. Several steps had been taken to minimize risk to downstream populations, and these had been posted on the Corps' webpage, which is continuously updated. Interested parties are encouraged to visit the website often throughout the 7-10 year repair period.

For Center Hill Lake, an immediate risk reduction measure was to maintain the pool at the bottom of the normal operating curve. This action lowered the summer pool approximately 8 feet to EL 640, the existing condition. Seepage studies indicate that additional lowering may be required during the repair period. As a result, the Corps prepared a Draft Environmental Impact Statement (DEIS) that evaluated several Center Hill Lake pool elevation alternatives. The Corps' outreach efforts include publications in the Federal Register, mass mailing of a Scoping Letter, circulation of the DEIS, and meetings with stakeholders (marina operators and water suppliers) and agencies. Comments received to date are summarized in the list below.. Copies of the letters and e-mail follow the table. Corps responses also appear on some of the emails, but have been copied into this list for the readers' convenience:

Page	Document
7.	U.S. Fish and Wildlife Service letter – February 23, 2007. Notification to be a Cooperating Agency. ***Corp Response:*** *Graciously accepts.*
8.	Federal Register – February 26, 2007. Notice of Intent to Prepare a Draft Environmental Impact Statement for Center Hill Dam and Lake. ***Corps Response:*** *First Publication.*
10.	Corps letter – April 9, 2007. Corps Scoping Letter soliciting input to alternative Center Hill Lake pool elevations. ***Corps Response:*** *First Notification.*
13.	City of Cookeville, Department of Water Quality Control, Ronnie Kelly, Director, e-mail – April 26, 2007. Cookeville withdrawals approximately 11 million gallons of water per day. Their intake is located in Center Hill Lake. Critical elevations are 609 and 615 for year-round withdrawal. During the summer months, water can be withdrawn from an alternate intake gate located at elevation 626. Lowering the lake limits withdrawal flexibility, limits access to the highest quality of water available and therefore increases treatment costs, and decreases pumping efficiency. ***Corps Response:*** *Comments taken under full consideration.*

14.	U.S. Fish and Wildlife Service letter – August 3, 2007. Response to the notification of intent to prepare a draft environmental impact statement. The agency identified potential impacts to the Caney Fork and Cumberland Rivers likely center around water quality and quantity issues directly related to tailwater discharges. Deviations from normal regulated flow patterns and typical temperature and dissolved oxygen regimes could adversely impact aquatic resources. The Agency acknowledges the Corps' detailed and on-going water quality monitoring and modeling to identify issues as they develop and predict and avoid potential problems before they arise. The Agency requests additional water quality monitoring and an assessment of biological integrity (macroinvertebrate and fish) in the Caney Fork River tailwater. The Agency also provided instruction in case an emergency drawdown. ***Corps Response:*** *The Corps agrees to the requested additional monitoring. A preliminary monitoring plan is found in this FEIS, Appendix A - Biological Assessment; Section 5 – Potential Conservation Measures. The Corps met with USFWS, TWRA, and TDEC on May 3, 2007 during an inter-agency meeting to discuss the intensive water quality monitoring that would be conducted by the Corps over the lifetime of the Center Hill repairs. The requested USFWS monitoring stations would be incorporated into the Corps' existing monitoring plan.*
16.	Corps letter – August 30, 2007. Notice of Availability of the Draft Environmental Impact Statement for a 45-day review closing on October 23, 2007. ***Corps Response:*** *Second Notification*
17.	Federal Register – September 7, 2007. Notice of Availability of the Draft Environmental Impact Statement for a 45-day review closing on October 23, 2007. ***Corps Response:*** *Second Publication.*
19.	Peter Johnson e-mail – September 5, 2007. Mr. Johnson states that he fully understands the need to repair Center Hill Dam and recommends Alternative 4, Environmentally Preferred (EL 635/623.5). Mr. Johnson hopes residents will have some say in the Corps' decision. ***Corps Response:*** *Comments are appreciated and will be considered in the final decision.*
20.	Brenda Tucker e-mail – September 10, 2007. Ms. Tucker wanted to know what areas could be affected if the dam breaks. ***Corps Response:*** *Ms. Tucker was referred to her county Emergency Manager to review inundation maps for her area. Ms. Tucker was informed that public meetings would be planned in potentially affected areas.*
21.	Sheila Schoenmann e-mail – September 11, 2007. Ms. Schoenmann wanted to know what areas could be affected if the dam breaks and how long will people have to leave. ***Corps Response:*** *Ms. Schoenmann was referred to her county Emergency Manager to review inundation maps for here area. Ms. Tucker was informed that public meetings would be planned in potentially affected areas.*
22.	City of Smithville, Mayor Taft Hendrixson letter – September 18, 2007. The Mayor states that the Smithville's only intake is located adjacent Center Hill Lake. Elevation 618 is the minimum elevation that would allow the intake to operate hydraulically, but lake elevations below EL 620 could cause pump turbulence which could result in the City

	being out of water. In addition, lake elevations below EL 623.5 could result in poor raw water quality and treatment difficulties. The Mayor requests that lake be maintained at EL 623.5 or higher. ***Corps Response:*** *Comments are appreciated and will be considered in the final decision*
23.	Tennessee Department of Environment and Conservation, Division of Water Supply letter – September 18, 2007. The Division reviewed the DEIS and evaluated the 9 pool elevation alternatives. The Division understands the need for dam repairs to minimize the risk for dam failure and protect the this water supply source. The Division requested a meeting between the State, affected utility districts, and the Corps prior t the selection of an alternative so that water systems could make modifications if necessary. ***Corps Response:*** *On October 12, 2007, the Corps meet with the State and utility districts to discuss the alternatives. The USFWS was also present. The following topics were discussed: status of dam repairs, minimum flows, future installation of an orifice gate, past and current lake elevation operations, effects of drought on lake operations, the use of spilling, generating, and sluicing, and potential water supply impacts and possible actions to minimize intake impacts. The 2006 Seepage Report and the 2007Consensus Report by the Peer Review were discussed. The Seepage Report notes significant reduction in seepage below EL 635. The Peer Review recommended lake elevations between 620 and 630 to significantly reduce risk of dam failure. A decision on the selected alternative is expected to be announced in January 2008.*
26.	Bob Richie e-mail – September 19, 2007. Mr. Richie asked if there was a summary report available and if there were a speaker available to talk at his church. ***Corps Response:*** *Mr. Richie was informed that the Corps does not have a shortened version of the DEIS. Mr. Richie was informed that public meetings would be planned to discuss the status of the project and inundation maps in potentially affected areas.*
27.	Mr. Michael Moon e-mail – September 22, 2007. Mr. Moon requested the status of the dam and its repairs. ***Corps Response:*** *Mr. Moon was informed that contractor proposals to repair the dam are being evaluated. In the meantime, the dam is under continuous surveillance. The Corps would use new articles, websites, and public meetings to keep the public informed.*
28.	Mr. Alan Sielbeck letter – September 25, 2007. Mr. Sielbeck has evaluated the lake elevation alternatives. He has made some tentative plans to reconfigure his boat dock and slips in the event the lake is lowered to EL 618. A substantial investment in hardware (cables and anchors) would be required. Gasoline, propane, electric, telephone, and sanitary sewer lines would have to be relocated. Some boats may not be able to exit the marina until the lake level reaches EL 623.5. At EL 618, the marina would be difficult to access and operate. The marina is valued in excess of 10 million dollars. Mr. Sielbeck recommends the selection of Alternative 4, Environmentally Preferred, (EL 635/623.5) ***Corps Response:*** *Comments are appreciated and will be considered in the final decision.*
30.	U.S. Department of Agriculture, Forest Service letter – October 2, 2007. The agency notes that activities as proposed would not likely affect the resources of the Daniel Boone National Forest. Additional contact with this agency is not necessary.
31.	U.S. Department of the Interior, Office of Environmental Policy and Compliance letter. –

	October 17, 2007. The Agency voiced concerns regarding the potential impact to trout should the tailwater warm enough to stress or potentially kill them. The Agency noted that the Corps should consider potential mitigative actions to avoid or minimize such impacts. The Agency raised concerns for the least tern and gray bats, and noted no mitigative actions were recommended in either the DEIS or the BA. ***Corps Response:*** *Mitigation measures to avoid or minimize impact to the trout are noted in the DEIS in Section 2.4 – Mitigation Measures. These measures including sluicing (intermittent releases of cold, turbulent, and well oxygenated water from a special gate at the base of the dam) and installation of an orifice gate over the sluice gate to provide continuous less turbulent, but still cold, well oxygenated releases. These measure have been incorporated into the BA which also cites potential impacts to the gray bat and mitigation measures to minimize impact. Mitigation measures were not included in the Draft BA. This oversight has been corrected in the Final BA. Comments are appreciated and will be considered in the final decision.*
34.	<u>Tennessee Department of Environment and Conservation, Division of Water Pollution Control letter</u> – October 16, 2006. The Division voiced concerns that lower lake elevations may affect water quality and designed uses including fish & aquatic life, livestock watering and wildlife, and irrigation. ***Corps Response:*** *The Corps shares the same concerns and have taken steps to minimize impacts to water quality and designated uses. The Corps currently maintains contact with several representatives of the Division including Mr. Howard. The Corps has had several partnering meetings with the Commissioner and Division Directors. The Corps will continue to coordinate with the State over the lifetime of the project. Comments are appreciated and will be considered in the final decision*
36.	<u>Tennessee Wildlife Resources Agency letter</u> – October 17, 2007. The Agency recommends Alternative 4, Environmentally Preferred (EL 635/623.5). ***Corps Response:*** *Comments are appreciated and will be considered in the final decision*.
37.	<u>U.S. Department of Energy, Southeastern Power Administration letter</u> – October 17, 2007. The Agency notes that Alternative 5 – Safety and Engineering Preferred (EL 630/618) will reduce available generation scheduling flexibility and the value of power peaking capability. The Agency recommends that the cost of the project should be assigned to the Dam Safety program. ***Corps Response:*** *Comments are appreciated and will be considered in the final decision*.
38.	<u>Environmental Protection Agency letter</u> – October 23, 2007. The Agency requested additional information regarding the following topics: <u>Alternatives</u> – Alternative 1 is described as the “normal” operating band, yet Alternative 3 is considered the “No Action.” Why? Why is Alternative 4 Environmentally Preferred and Alternative 5 Safety & Engineering Preferred? ***Corps Response:*** *Alternative 1 represents customary summer and winter pool elevations, the “normal” operating band for a “normal” low risk dam. Center Hill Dam has been classified as a high risk dam. To reduce the risk of failure, the pool was lowered to follow Alternative 3, which is our “without project” alternative (existing condition). The without-project situation is that which would prevail without the project (repair the dam).*

A comparison of the alternatives is found in the DEIS in Table 3. Alternative 1 and 2 would support all the resources, but with a severe risk to safety. Alternative 3 still carries a severe risk to safety as compared to the remaining alternatives. However, as safety increases, impacts to the resources increase. Safety is tied to risk of dam failure. The dam has a higher chance of failing with increasing hydraulic pressure as measured by increasing seepage (leaking). When seepage increases, the water becomes muddy - an indication of piping and soil being washed away. The following two figures represent leaking below the dam on the Right Rim (Lower Leak Weir) and Left Rim walls. Both show that as the lake elevation rises, the seepage increases. As can be seen in the right rim, seepage exceeds the weir and cannot be measured. From a safety point of view alone, the lower the lake the better, however, the resources need to considered.

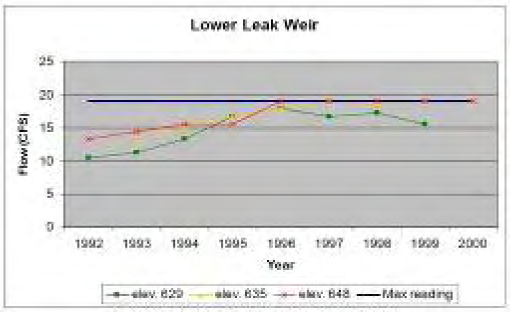
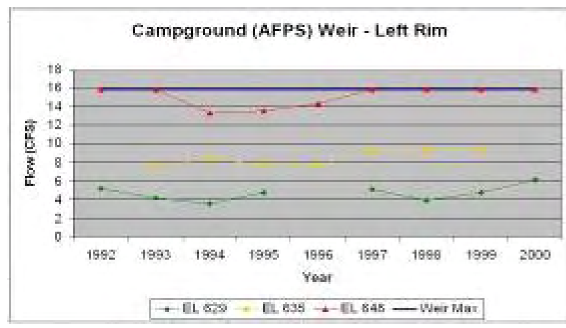


Figure 3-36 Lower Leak Weir data from 1992 to 2000.
Readings plotted for three different pool elevations over time.



<u>Water Quality/Water Quantity</u> – EPA recommends implementing mitigation measures as described in the DEIS Section 2.4. Water supply impacts for EL 618 in Alternative 5 is not the same as in 7. There is no discussion of water supply impacts to the water utility located below the dam.

Corps Response: *Mitigation measures as described in the DEIS in Section 2.4.2, 2.4.3, and 2.4.5, have been implemented, alone or in combination, as needed, for the last four years. The orifice gate (Section 2.4.1) has been delayed until 2008. Impacts at EL 618 for Alternative 5 and 7 will be reviewed. Minimum flow provides water to the downstream utility. The utility is contacted when the Corps is sluicing so they can adjust water treatment if necessary.*

<u>Mitigation and Monitoring Measures</u> – EPA requests clarification on the mitigation measures described in Section 2.4. EPA requests information regarding water quality monitoring for the project. Does the Corps have a public outreach plan?

Corps Response: *Clarification for Section 2.4 is noted above. The Corps can send EPA profile data electronically, as it does to the Tennessee Division of Water Pollution Control. The Corps and TVA have been sending their data for years to the Planning and Standards section to be used in 305(b) assessments. Section 5 in the Biological Assessment shows additional water quality, macroinvertebrate, and fish monitoring requested from USFWS. The Corps website, listed in the DEIS, provides the public with detailed information regarding Center Hill. The Corps is part of the Cumberland River Compact (CRC) and has produced a report titled, "Water Management Report for the*

	Cumberland River Basin." Please visit the CRC website to access this report: http://www.cumberlandrivercompact.org/programs_wmr.shtml Preferred Alternative –EPA requests additional inform regarding the degree in change in the risk of dam failure for each alternative and identification of distress indicators. ***Corps Response:*** *The Corps will provide EPA with a copy of the Seepage Report. The Peer Report listed on the Corps' website explains risk in detail. Distress indicators are explained in the Seepage Report and listed in the DEIS in Section 1.4 – Purpose and Need for Action. Comments are appreciated and will be considered in the final decision.*
44.	Tennessee Valley Authority letter – October 24, 2007. The Agency recommends Alternative 4, Environmentally Preferred (EL 630/623.5). ***Corps Response:*** *Comments are appreciated and will be considered in the final decision*.
45.	City of Cookeville, Department of Water Quality Control, Ronnie Kelly, Director, e-mail – October 25, 2007. Mr. Kelly recommends the selection of Alternatives 1 – 4 for future pool elevations during dam repairs. Any of the other alternatives will require the use of the back-up pump. ***Corps Response:*** *Comments are appreciated and will be considered in the final decision*.

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1070
NASHVILLE, TENNESSEE 37202-1070

IN REPLY REFER TO

FEB 23 2007

Project Planning Branch

Lee Barclay, PhD
Supervisor
Tennessee Field Office
U.S. Fish and Wildlife Service
446 Neal Street
Cookeville, Tennessee 38501

Dear Dr. Barclay:

Center Hill Dam impounds Center Hill Lake in central Tennessee. Several engineering studies have identified a heightened level of risk at Center Dam due to increasing seepage problems under and around the dam that worsen during continual high lake levels. As a result, the Corps plans to maintain lower lake levels, but still within the operations curve, to reduce pressure on the dam foundation, abutments, and rim walls. This action has been taken to reduce risk to the public's safety and welfare. This operation will be in effect until repair of the dam or new information allows return to routine pool elevations. Although not expected, the Corps recognizes that if seepage conditions worsen, or new information determines a need to further reduce risk, the lake levels could be significantly lowered.

The Corps is preparing and plans to circulate a Draft Environmental Impact Statement which serves to cover possible impacts due to significant changes in lake levels that could occur during the repair of the dam's foundation and abutments. As discussed in our telephone conversation on February 20, 2007, this action could have a direct impact on federally listed or proposed species. We acknowledge your agreement to serve as a cooperating agency in this matter. Should you have any questions, the point of contact is Joy Broach. She can be reached at the address listed above or by calling (615) 736-7956.

Sincerely,

Steven J. Roemhildt, P.E.
Lieutenant Colonel
Corps of Engineers
District Engineer

SUMMARY: In accordance with 37 CFR 404.6 and 404.7, announcement is made of the availability for licensing of the invention set forth in U.S. Patent No. 7,177,623 entitled "Localized Cellular Awareness and Tracking of Emergencies," issued on February 13, 2007. The United States Government, as represented by the Secretary of the Army, has rights in this invention.

ADDRESSES: Office of Research and Technology Applications, SDMC–RDTC–TDL (Ms. Susan D. McRae), Bldg. 5220, Von Braun Complex, Redstone Arsenal, AL 35898.

FOR FURTHER INFORMATION CONTACT: Ms. Joan Gilsdorf, Patent Attorney, e-mail: *joan.gilsdorf@smdc.army.mil* (256) 955–3213 or Ms. Susan D. McRae, Office of Research and Technology Applications, e-mail: *susan.mcrae@smdc.army.mil*; (256) 955–1501.

SUPPLEMENTARY INFORMATION: The invention pertains to establishing a three-way call between a wireless 911 caller, an emergency 911 dispatcher, and security/law enforcement personnel assigned to monitor a particular property. When a wireless 911 caller makes a 911 call from a specific property, the wireless network provides the caller's automatic location identification (ALI) information to a Localized Cellular Awareness and Tracking of Emergencies (LoCATE) System Unit (LSU) before the call is routed to the 911 dispatcher. The LSU uses the ALI information to determine the phone numbers of the surveillance property's assigned security/law enforcement personnel (*e.g.*, a building security guard) and provides these phone numbers to the wireless network. The LSU requests the wireless network to establish a three-way call between the 911 caller, the 911 emergency dispatcher, and the surveillance property's assigned security/law enforcement personnel. Thus, the invention provides a real-time communication link with a specific property's assigned security/law enforcement personnel, who can provide the most immediate response to an emergency occurring at the property before the arrival of the traditional or official first responders who are dispatched by the 911 dispatcher. Possible surveillance applications include buildings, campuses, national monuments, crime zones, airports, sports arenas, parades, amusement parks, bridges, borders, highways, waterways, special events, etc.

Brenda S. Bowen,

Army Federal Register Liaison Officer.

[FR Doc. 07–852 Filed 2–23–07; 8:45 am]

BILLING CODE 3710–08–M

DEPARTMENT OF DEFENSE

Department of the Army; Corps of Engineers

Intent To Prepare a Draft Environmental Impact Statement To Address Operational Changes at Center Hill Dam, Center Hill Lake, DeKalb County, TN, That Could Affect Pool Elevations

AGENCY: Department of the Army, U.S. Army Corps of Engineers, DoD.

ACTION: Notice.

SUMMARY: The Corps of Engineers (Corps) is preparing a Draft Environmental Impact Statement (DEIS) to address operational changes at Center Hill Dam that could affect pool elevations. Center Hill Dam impounds Center Hill Lake in central Tennessee. The DEIS is necessary to provide National Environmental Policy Act (NEPA) compliance to address changes that could include, but are not limited to water quality, aquatic, riparian, and terrestrial habitat, recreation, water supply, flood storage, economics, hydropower production, and safety as a result of operating Center Hill Lake below normal pool elevations for extended periods of time. Several engineering studies have identified a heightened level of risk at Center Hill Dam due to increasing seepage problems under and around the dam. Since March 2005, the Corps has attempted to keep fall, winter and early spring lake levels from extreme rises due to high inflow. Seepage problems are made worse during continual high lake levels. As a result, the Corps plans to maintain lower lake levels, but still within the operations curve, to reduce pressure on the dam foundation, abutments, and rim walls until a permanent remedy is in place. A major grouting project to address the dam seepage is scheduled for the fall of 2007, followed by installation of a cutoff wall through the earthen portions of the dam and adjoining rim walls. Although not anticipated, the Corps may have to lower the lake pool significantly below the operating pool should seepage conditions worsen, or new information determine this action is necessary to reduce risk. This notice serves to initiate the NEPA process. The Corps plans to prepare and circulate a DEIS which serves to cover possible impacts due to extreme changes in lake levels that could occur during the repair of the dam's foundation and abutments.

DATES: Written comments concerning issues to be considered in preparing the DEIS, must be received by the Corps of Engineers on or before March 28, 2007.

ADDRESSES: Written comments on issues to be considered in the DEIS shall be mailed to: Joy Broach, Project Planning Branch, Nashville District Corps of Engineers, P.O. Box 1070 (PM–P), Nashville, TN 37202–1070. Comments may also be e-mailed to: *CenterHill.Repair@lrn02.usace.army.mil.*

FOR FURTHER INFORMATION CONTACT: For additional information concerning the notice, please contact Joy Broach, Environmental Team, (615) 736–7956, Linda Adcock, Center Hill Dam Seepage Major Rehabilitation Project Manager, (615) 736–5940, or Public Affairs Office, (615) 736–7161.

SUPPLEMENTARY INFORMATION:

1. Center Hill Dam was designed in the 1930s, constructed in the 1940s, and impounded in the early 1950s. The dam was built on karst geology using accepted engineering practices of the day. Since the 1960s, seepage flows through the dam's right abutment and left rim wall have been monitored, and recently became a concern with increased seepage and development of turbid flows through springs below the left rim wall. Signs of seepage increase through the main dam and saddle dam foundations have also been noted. A formal risk assessment is currently being conducted to determine if a need exists to significantly alter lake levels outside the normal operations curve to reduce risk to people and property.

2. A comprehensive plan for repairs has been approved; however, these repairs will take a number of years to implement. Until the repairs are sufficiently complete, the Corps has determined that it is in the public's interest to operate Center Hill Lake at the lower range of the operations curve. Many rehabilitation alternatives were considered and potential impacts analyzed and are discussed in the following NEPA documents: *Proposed Center Hill Dam Seepage Rehabilitation, Environmental Assessment, July 2005*; and *Proposed Center Hill Dam Seepage Rehabilitation, Environmental Assessment Supplement 1, March 2006.* These documents have been included by reference. No significant environmental and economic consequences are anticipated under current dam repair plans; however,

some water intakes and boat ramps may need to be extended for safe operation.

3. Though not expected, the Corps recognizes that if seepage conditions worsen, or new information determines that the lake elevations should be significantly changed to ensure the public's health, safety, and welfare; then the following resources could be significantly impacted:

(1) The cold-water fisheries both in the lake and tailwater;

(2) Water quality throughout the Caney Fork River and downstream in the Cumberland River;

(3) Federally listed threatened and endangered species;

(4) Designated uses of the waterway including fish and aquatic life, livestock watering and wildlife, irrigation;

(5) And economics including electric power production, municipal and industrial water supply, recreation, navigation, flood damage reduction, and disruption to communities, jobs, and other related factors.

4. *Current Actions to Reduce Risk.* Several actions have already been taken to reduce the risk. Prior to 2005, spring rains were captured in the reservoir to maximize downstream flood protection and hydropower generation. Beginning in March 2005, the pool was managed more aggressively to reduce inflow peaks and adhere more closely to the prescribed guide curves. In 2006, continuous surveillance was initiated at the dam. This involves providing patrols to monitor the dam, known seepage and trouble spots, and downstream areas. Currently, the Corps is conducting exploratory drilling to assess the limestone rock condition and key access points for future grouting activities. Additional coordination and exercises have been held with state and local emergency management agencies. These agencies will be provided flood inundation maps to help coordinate emergency evacuation planning. The Corps has improved its emergency notification procedures, increased instrumentation in, on, and around the dam, and conducted numerous public meetings to advise the public of problems with the dam.

5. A DEIS will be undertaken to review current actions taken and to consider other possible alternatives to reduce stress on the dam.

6. This notice serves to solicit comments from the public; Federal, State and local agencies and officials; Indian Tribes; and other interested parties in order to consider and evaluate impacts of these proposed activities. Any comments received by the agency will be considered in determining future operations. In the decision-making process, comments are used to assess impacts on public health and safety, endangered species, historic properties, water quality, water supply and conservation, economics, aesthetics, wetlands, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, energy needs, food and fiber production, mineral needs, considerations of property ownership, general environmental effects, and in general, the needs and welfare of the people.

7. Activities proposed that may require a review under the guidelines promulgated by the Administrator, Environmental Protection Agency (EPA), under authority of Section 404(b)(1) of the Clean Water Act (40 CFR part 230) include fill placement for water intake extensions, boat ramp extensions, and other mitigation actions.

8. Other Federal, State, and local approvals that may be required for proposed work are as follows:

a. Section 401 water quality certification from the Tennessee Department of Environment and Conservation.

b. Coordination with the U.S. Fish and Wildlife Service for the Endangered Species Act and Fish and Wildlife Coordination Act.

c. Coordination with the Tennessee Wildlife Resources Agency.

d. Coordination with the State Historic Preservation Officer and President's Advisory Council on Historic Preservation.

9. Significant issues to be analyzed in the DEIS include impacts to fisheries, tailwater mussel resources, water quality, flood control, recreation, navigation, water supply, electric power production, economics, and community development. The U.S. Fish and Wildlife Service has agreed to be a Cooperating Agency on the DEIS. A DEIS should be available in June 2007.

10. *Public Meetings:* At present, no public meetings have been scheduled to scope for potential issues to be evaluated in the DEIS. Requests for public meetings should be directed to Mr. William Peoples, Chief, Public Affairs Office, U.S. Army Corps of Engineers, Nashville District, Nashville, TN, 37202–1070. Mr. Peoples may be reached by telephone at (615) 736–7834.

Brenda S. Bowen,

Army Federal Register Liaison Officer.

[FR Doc. 07–853 Filed 2–23–07; 8:45 am]

BILLING CODE 3710–GF–M

DEPARTMENT OF DEFENSE

Department of the Army; Corps of Engineers

Intent To Prepare a Draft Environmental Impact Statement (DEIS) for the Development of an Inlet Management Plan That Includes the Repositioning and Realignment of the Main Ebb Channel of Rich Inlet and To Use the Material To Nourish Figure Eight Island, North of Wilmington, New Hanover County, NC

AGENCY: Department of the Army, U.S. Army Corps of Engineers, DoD.

ACTION: Notice of intent.

SUMMARY: The U.S. Army Corps of Engineers (COE), Wilmington District, Wilmington Regulatory Field Office has received a request for Department of the Army authorization, pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbor Act, from Figure "8" Beach Homeowners Association to develop a management plan for Rich Inlet that would mitigate chronic erosion on the northern portion of Figure Eight Island so as to preserve the integrity of its infrastructure, provide protection to existing development, and ensure the continued use of the oceanfront beach along the northernmost three miles of its oceanfront shoreline. Figure Eight Island is an unincorporated privately developed island located on the southeast coast of North Carolina, approximately eight miles north of Wilmington. The island is bordered to the south by Mason Inlet and Wrightsville Beach; and to the north by Rich Inlet and Lea-Hutaff Island, an undeveloped, privately-owned island.

The inlet management plan would involve the repositioning and realignment of the main ebb channel of Rich Inlet to a location closer to the north end of Figure Eight Island. The intended alignment is to be essentially perpendicular to the oceanfront shorelines of the adjacent islands. The new channel position would be periodically maintained with maintenance episodes dictated by natural shifts in the channel position that produce unfavorable shoreline responses on the north end of Figure Eight Island. While the main focus of the project is to relocate the main ebb bar channel, consideration will also be given to possible alterations in Nixon Channel and Green Channel to determine if such modification would enhance the stability of the new channel. Nixon Channel meanders along a southwesterly path on the landward

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1070
NASHVILLE, TENNESSEE 37202-1070

REPLY TO
ATTENTION OF

April 9, 2007

Project Planning Branch

TO ALL INTERESTED PARTIES:

The Corps of Engineers, Nashville District, is preparing a Draft Environmental Impact Statement (DEIS) to address proposed operational changes at Center Hill Dam that could affect pool elevations in Center Hill Lake. Center Hill Dam is located in DeKalb County in central Tennessee.

Center Hill Dam, impounded in the early 1950s, was built on karst geology using accepted engineering practices of the day. Since the 1960s, seepage flows through the dam's right abutment and left rim wall have been monitored. Repairs have been made at various times and include grout injection into the dam foundation, earthen embankment, right abutment and left rim. These repairs were effective. However, recent increased seepage and development of turbid flows through springs below the left rim wall have become concerns. A comprehensive plan to repair the dam was approved, but will take a number of years to complete. The plan includes a major grouting project scheduled to start in fall 2007, to address the dam seepage, followed by installation of a cutoff wall through the main dam and saddle dam. These repairs along with other alternatives were discussed in the following National Environmental Policy Act (NEPA) documents: *Proposed Center Hill Dam Seepage Rehabilitation, Environmental Assessment, July 2005*; and *Proposed Center Hill Dam Seepage Rehabilitation, Environmental Assessment Supplement 1, March 2006*. A Finding of No Significant Impact (FONSI) was signed for both of these documents.

Since March 2005, the Corps has attempted to keep fall, winter and early spring lake levels from extreme rises due to high inflow. Seepage problems are made worse during continual high lake levels. Until repairs are sufficiently complete, the Corps has determined that it is in the public's interest to operate Center Hill Lake at the lower range of the operations curve to reduce pressure on the dam foundation, abutments, and rim walls. Lower lake levels year round would still be within the normal operation range. Although not expected, the Corps may have to lower lake levels significantly further should seepage conditions worsen, or new information determines this action is necessary. Currently, a formal risk assessment is being conducted to determine if a need exists to drop the pool level significantly below the normal operation range to reduce risk to people and property.

The DEIS is necessary to provide NEPA compliance to address impacts that could occur due to possible changes in lake levels. These changes could include, but are not limited to water quality, aquatic, riparian, and terrestrial habitat, recreation, water supply, flood storage, economics, hydropower production, and safety.

This letter serves to solicit scoping comments from the public; federal, state and local agencies and officials; Indian Tribes; and other interested parties in order to consider and evaluate the impacts of proposed operational changes that could affect typical pool elevations for an extended period of time. Any comments received during the comment period will be considered in the NEPA process. We encourage comments not only about the immediate project area, but also of plans or proposals for any other development that may impact or influence project resources.

This letter also serves to initiate the public involvement requirements of Section 106 of the National Historic Preservation Act of 1966, as amended. Section 106, implemented by regulations at 36CFR800, requires the Corps of Engineers to consider the effects of its undertakings on historic properties. Because the Corps plans to maintain lower lake levels within the current operational curve, it is the Corps' finding that archeological sites located within the reservoir pool will not be affected; however, if the Corps has to lower lake levels significantly below the operating pool should seepage conditions worsen, appropriate archeological identification studies will be initiated in consultation with the Tennessee State Historic Preservation Officer and other offices as necessary.

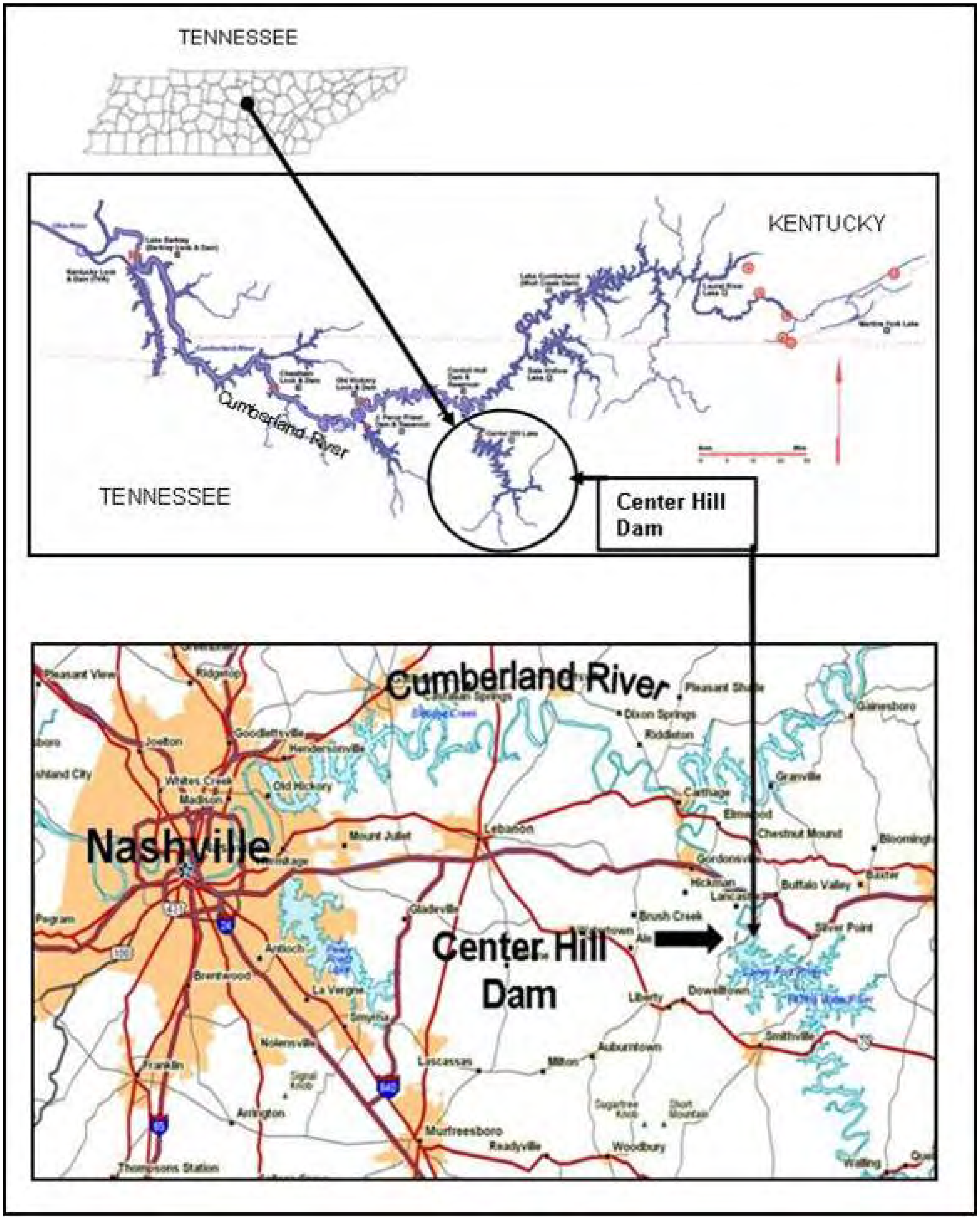
The public is invited to submit written comments no later than thirty (30) days from the date of this letter. You may send your comments to the address above, attention Ms. Joy Broach, or by calling Ms. Broach at (615) 736-7956. Comments may also be e-mailed to: *CenterHill.Repair@lrn02.usace.army.mil*.

Sincerely,

Steven J. Roemhildt, P.E.
Lieutenant Colonel
Corps of Engineers
District Engineer

Enclosure

Figure 1. Center Hill Dam and Lake Location Map.



From: Ronnie Kelly [mailto:rjk@cookeville-tn.org]
Sent: Friday, April 27, 2007 10:37 AM
To: Repair, CenterHill LRN
Subject: Scoping Comments on Center Hill Pool Elevation

April 26, 2007

Mr. Steven J. Roemhildt, P.E.
Lieutenant Colonel
Corps of Engineers
District Engineer

Dear Mr. Roemhildt:

I have reviewed the scoping letter published on April 9, 2007 which seeks comment on the proposed operational changes of the pool elevation of Center Hill Reservoir. I would like to offer the following comments from the City of Cookeville.

The City of Cookeville withdraws approximately 11 million gallons of water per day from Center Hill Reservoir for processing at our Water Treatment Facility. The treated water is used for drinking, fire, and industrial use throughout the region. Cookeville provides potable water to the City of Baxter, City of Algood, Cookeville Boat Dock Utility District, Bangham Utility District, Double Springs Utility District, O'Connor Utility District, and the Old Gainesboro Grade Utility District.

Cookeville's water intake is located on Mine Lick Creek. The pump suction is located at elevation 609.5 while the floor elevation of the intake structure is located at elevation 609. Cookeville has two raw water intake gates located on the intake structure. The top of our lower intake gate, which is a 6' x 4', is located at elevation 615. The bottom of the upper intake gate is located at an elevation of 626. During normal pool operation Cookeville is able to withdraw water from the upper intake gate and/or the lower intake gate. This allows Cookeville to evaluate the quality and treatability of the raw lake water at different depths and withdraw the highest quality water for treatment. Operating the pool level below Cookeville's upper intake gate level would limit Cookeville's ability to withdraw the highest quality water for treatment and thus increase the cost of treatment. As the level of the pool is lowered, from its normal operational level, our ability to pump water from the lake is decreased. This loss of capacity is due to the increase in suction head created on the pumps when the lake pool is lowered.

If you have any questions concerning my comments please feel free to give me a call @ 931-520-5259..

Sincerely,

Ronnie J. Kelly, Director
City of Cookeville
Department of Water Quality Control
rjk@cookeville-tn.org
931-520-5259

United States Department of the Interior

FISH AND WILDLIFE SERVICE
446 Neal Street
Cookeville, TN 38501

August 3, 2007

Ms. Joy Broach
Project Planning Branch
U.S. Army Corps of Engineers
P.O. Box 1070
Nashville, Tennessee 37202-1070

Re: FWS #07-FA-0554

Dear Ms. Broach:

We are in receipt of your notification of intent to prepare a draft environmental impact statement to address the potential impacts of proposed actions associated with repairs to Center Hill Dam, left rim and right rim of the Dam, and the nearby Saddle Dam in DeKalb County, Tennessee.

Potential impacts of the repair activities upon the Caney Fork River and Cumberland River will likely center around water quality and quantity issues directly related to tailwater discharges. Deviations from normal regulated flow patterns and typical temperature and dissolved oxygen regimes could adversely impact aquatic resources. This will particularly be the case given the District's decreased ability to regulate the quantity and quality of water available for tailwater discharges. We were pleased to learn during recent discussions with Planning Branch staff (May 3, 2007 meeting) that detailed water quality monitoring and predictive computer modeling are currently being implemented to identify issues as they evolve and predict and avoid potential problems before they arise.

The Center Hill Dam tailwater is typically cold. For this reason, rare aquatic species, primarily native mussels (including federally listed freshwater mussels) that historically occurred in somewhat large populations in the Caney Fork River, now appear to only occur at relatively few locations within the Cumberland River. Most remnant mussel populations are confined to areas in the Cumberland River that continue to experience significant flow as the result of tailwater releases. As a consequence of impoundment and consistent low water temperature, these specimens are believed to no longer reproduce and are dominated by older individuals that were present when the system was impounded. Consideration has been given in recent years to removal of these specimens for use in propagation efforts, and in this regard their potential value to the survival of their species remains significant.

In addition to the areas along the Caney Fork River that the Nashville District have agreed to monitor, we request that additional monitoring of temperature, dissolved oxygen, flow, and biological integrity (macroinvertebrate and fish community) occur at Happy Hollow (5 RM below the dam), Stonewall (RM 11), and at Carthage. Over the course of the proposed seven-year life of the project, quarterly (seasonal) monitoring at these stations would provide the resource agencies with valuable data on potential responses in the tailwater as the zone of cold water in the reservoir diminishes and minimum flows below the dam warm.

Potential adverse impacts may also occur to more common aquatic resources adapted to cold tailwaters or existing warmwater impoundments. Many of these species, particularly fish species, are of high recreational importance and should be considered during the District's impact evaluation. However, impacts to these species would likely be temporary, and populations will ultimately recover to pre-project status.

The information provided also indicated that the Corps may have to lower the lake level significantly should seepage conditions worsen, or new information determines this action is necessary. If the Corps determines it necessary to significantly lower the lake level in a short period of time, emergency consultation procedures should be pursued by the District pursuant to 50 CFR 402.05 prior to initiating the drawdown. This section of the Endangered Species Act allows Federal agencies to incorporate endangered species concerns during response to an emergency without obstructing or delaying decisions made to protect human lives. We have previously discussed these alternative consultation procedures with the Environmental staff regarding the Wolf Creek Dam project and recommend that they be followed with the Center Hill Dam project whenever applicable and appropriate.

We request that the Nashville District keep the Fish and Wildlife Service and Tennessee Wildlife Resources Agency apprised of actual and predicted water quality conditions and/or changes during the project period in order to allow sufficient time to recommend and implement potential remedial actions to protect rare species within the Cumberland River system.

Please contact Robbie Sykes of my staff at 931/528-6481 (ext. 209) if you have questions about these comments.

Sincerely,

James C. Widlak

for Lee A. Barclay, Ph.D.
Field Supervisor

xc: Robert Todd, TWRA, Nashville, TN

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1070
NASHVILLE, TENNESSEE 37202-1070

IN REPLY REFER TO

Project Planning Branch

AUG 3 0 2007

TO ALL INTERESTED PARTIES:

The Corps of Engineers, Nashville District has prepared a Draft Environmental Impact Statement (DEIS) titled: Center Hill Dam and Lake, DeKalb County, Tennessee, Changes to Center Hill Lake Elevations, August 2007. The Tennessee Valley Authority and the U. S. Fish and Wildlife Service are cooperating agencies.

The intent of the DEIS is to provide National Environmental Policy Act coverage for changes that include, but are not limited to water quality, aquatic, riparian, and terrestrial habitat, recreation, water supply, flood storage, economics, hydropower production, and safety as a result of operating Center Hill Lake significantly below normal pool elevations for extended periods of time. The DEIS will cover cumulative effects and compliance with Section 106 of the Historic Preservation Act. Coordination with the U.S. Fish and Wildlife Service will include a Biological Assessment/Opinion for the Endangered Species Act and a Fish and Wildlife Coordination Act Report.

The public is invited to submit written comments no later than Friday, **October 23, 2007**. You may send your comments to the Address above. Further information may be obtained by writing to the same address or by telephoning Ms. Broach at (615) 736-7956. An electronic copy of the DEIS can be found at http://www.lrn.usace.army.mil/CenterHill/. Comments may also be e-mailed to: CenterHill.Repair@lrn02.usace.army.mil.

Sincerely,

William R. Barron, Jr., P.E.

William R. Barron, Jr., P.E.
Acting Chief, Project
Planning Branch

What Is the Next Step in the Process for This ICR?

EPA will consider the comments received and amend the ICR as appropriate. The final ICR package will then be submitted to OMB for review and approval pursuant to 5 CFR 1320.12. At that time, EPA will issue another **Federal Register** notice pursuant to 5 CFR 1320.5(a)(1)(iv) to announce the submission of the ICR to OMB and the opportunity to submit additional comments to OMB. If you have any questions about this ICR or the approval process, please contact the technical person listed under **FOR FURTHER INFORMATION CONTACT**.

Dated: August 10, 2007.

Matthew Hale,

Director, Office of Solid Waste.

[FR Doc. E7–17690 Filed 9–6–07; 8:45 am]

BILLING CODE 6560–50–P

ENVIRONMENTAL PROTECTION AGENCY

[ER–FRL–6690–8]

Environmental Impact Statements and Regulations; Availability of EPA Comments

Availability of EPA comments prepared pursuant to the Environmental Review Process (ERP), under section 309 of the Clean Air Act and Section 102(2)(c) of the National Environmental Policy Act as amended. Requests for copies of EPA comments can be directed to the Office of Federal Activities at 202–564–7167. An explanation of the ratings assigned to draft environmental impact statements (EISs) was published in the **Federal Register** dated April 6, 2007 (72 FR 17156).

Draft EISs

EIS No. 20070169, ERP No. D–GSA–J80047–CO, Denver Federal Central Site Plan Study, Master Site Plan, Implementation, City of Lakewood, Jefferson County, CO

Summary: EPA expressed environmental concern about construction dust and emission impacts on nearby schools and a hospital. EPA requested that mitigation measures be developed. Rating EC2.

EIS No. 20070209, ERP No. D–FHW–C59000–NY, Long Island Truck-Rail Intermodel (LITRIM) Facility, Construction and Operation, Right-of Way Acquisition, Town of Islip, Suffolk County, NY

Summary: EPA expressed environmental concern about air quality impacts, including the need for a General Conformity analysis and PM2.5 hotspot analysis. Rating EC2.

EIS No. 20070230, ERP No. D–FHW–C40171–NY, NYS Route 17 at Exit 122 Interchange Project, To Improve the Safety and Operation, Right-of-Way Acquisition, Town of Wallkill, Orange County, NY

Summary: EPA expressed environmental concern about air quality impacts, wetlands impacts, and the need for a mitigation plan. Rating EC2.

EIS No. 20070253, ERP No. D–BIA–G08012–NM, Desert Rock Energy Project, Construction and Operation of Coal-Fired Power Plant, Right-of-Way Permit, Navajo Nation Indian Reservation, San Juan County, NM

Summary: EPA expressed environmental concern about coal combustion byproduct disposal and dust emissions. EPA requested a comprehensive groundwater monitoring program, additional mitigation for reducing dust emissions, and clarification of the project proponent's commitment to reduce mercury emissions. Rating EC2.

EIS No. 20070282, ERP No. D–AFS–K65330–00, Sierra Nevada Forests Management Indicator Species Amendment (MIS), Proposes to Adopt a Common List of Management Indicator Species (MIS), and Amending Land & Resource Management Plans for Following Ten Forests: Eldorado, Inyo, Lassen, Modoc, Plumas, Sequoia, Sierra, Stanislaus and Tahoe National Forests and Lake Tahoe Basin Management Unit, Several Counties, CA and Douglas, Esmeralda, Mineral Counties, NV

Summary: EPA expressed concerns about the ability of the monitoring system to address Forest-specific unique resources, issues, and concerns. EPA suggests that past collaborative decisions be integrated into the proposed action. Rating EC2.

EIS No. 20070306, ERP No. D–NPS–J61112–CO, Curecanti National Recreation Area Resource Protection Study, Gunnison and Montrose Counties, CO

Summary: EPA does not object to the proposed action. Rating LO.

EIS No. 20070288, ERP No. DA–NOA–K91012–00, Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region, Amendment 14 to the Fishery Management Plan, Additional Information to Analyze a Range of Management Alternatives to End Bottomfish Overfishing in the Hawaiian Archipelago, HI, GU, and AS

Summary: EPA expressed environmental concern about potential increases in barotrauma mortality in non-target bottomfish species from the preferred alternative's Total Available Catch approach, and recommended mitigation be included to minimize this impact. Rating EC2.

EIS No. 20070284, ERP No. DS–DOE–K08024–CA, Sacramento Area Voltage Support Project, Updated Information, Proposal to Build a Double-Circuit 230-kV Transmission Line, Placer, Sacramento and Sutter Counties, CA

Summary: EPA expressed environmental concern about impacts to air quality and aquatic resources. EPA recommends limiting operating periods and fencing sensitive resources, such as vernal pools, during construction. Rating EC2.

Final EISs

EIS No. 20070302, ERP No. F–USA–G15001–NM, Cannon Air Force Base (AFB), Proposal to Beddown, or Locate Air Force Special Operations Command (AFSOC), Implementation, Base Realignment and Closure (BRAC), NM

Summary: No formal comment letter was sent to the preparing agency.

Dated: September 4, 2007.

Ken Mittelholtz,

Environmental Protection Specialist, Office of Federal Activities.

[FR Doc. E7–17691 Filed 9–6–07; 8:45 am]

BILLING CODE 6560–50–P

ENVIRONMENTAL PROTECTION AGENCY

[ER–FRL–6690–7]

Environmental Impacts Statements; Notice of Availability

Responsible Agency: Office of Federal Activities, General Information (202) 564–7167 or *http://www.epa.gov/compliance/nepa/.*

Weekly receipt of Environmental Impact Statements filed 08/27/2007 through 08/31/2007.

Pursuant to 40 CFR 1506.9.

EIS No. 20070374, Final EIS, SFW, PR, Vieques National Wildlife Refuge Comprehensive Conservation Plan, Implementation, Vieques, PR. *Wait Period Ends:* 10/09/2007. *Contact:* Jim Oland 410–573–4592.

EIS No. 20070375, Final EIS, AFS, AK, Kuiu Timber Sale Area, Proposes to Harvest Timber and Build Associated Temporary Roads, U.S. Army COE section 10 and 404 Permits, North Kuiu Island, Petersburg Ranger

District, Tongass National Forest, AK. *Wait Period Ends:* 10/09/2007. *Contact:* Tiffany Benna 907–772–3871.

EIS No. 20070376, Final EIS, FRC, 00, Hells Canyon Hydroelectric Project, Application for Relicensing to Authorize the Continued Operation of Hydroelectric Project, Snake River, Washington and Adams Counties, ID and Wallowa and Baker Counties, OR. *Wait Period Ends:* 10/09/2007. *Contact:* Andy Black 1–866–208–3372.

EIS No. 20070377, Draft EIS, COE, TN, Center Hill Dam and Lake Project, Changes to Operational Guide Curves Pool Elevations, Chancey Fork River and Cumberland River, Dekalb County, TN. *Comment Period Ends:* 10/23/2007. *Contact:* Joy Broach 615–736–7956.

EIS No. 20070378, Final EIS, VAD, CA, Fort Rosecrans National Cemetery Annex, Construction and Operation, Located at Marine Corps Air Station (MCAS) Miramar, Point Loma, San Diego County, CA. *Wait Period Ends:* 10/09/2007. *Contact:* Hiphill Clemente 619–532–3781.

Amended Notices

EIS No. 20070253, Draft EIS, BIA, NM, Desert Rock Energy Project, Construction and Operation of Coal-Fired Power Plant, Right-of-Way Permit, Navajo Nation Indian Reservation, San Juan County, NM, *Comment Period Ends:* 10/09/2007. *Contact:* Harrilene Yazzie 505–863–8286.

Revision of FR Notice Published 06/22/2007: Reopening Comment Period from 8/20/2007 to 10/09/2007.

Dated: September 4, 2007.

Ken Mittelholtz,

Environmental Protection Specialist, Office of Federal Activities.

[FR Doc. E7–17695 Filed 9–6–07; 8:45 am]

BILLING CODE 6560–50–P

ENVIRONMENTAL PROTECTION AGENCY

[EPA–HQ–OPP–2007–0191; FRL–8146–4]

Pesticide Program Dialogue Committee, Pesticide Registration Improvement Act Process Improvement Workgroup; Notice of Public Meeting

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice.

SUMMARY: EPA's Pesticide Program Dialogue Committee (PPDC), Pesticide Registration Improvement Act (PRIA) Process Improvement Workgroup will hold its ninth public meeting on September 27, 2007. An agenda for this meeting is being developed, and will be posted on EPA's website. The workgroup is developing advice and recommendations on topics related to EPA's registration process.

DATES: The meeting will be held on Thursday, September 27, 2007 from 1 p.m. to 4 p.m. To request accommodation of a disability, please contact the person listed under **FOR FURTHER INFORMATON CONTACT**, preferably at least 10 days prior to the meeting, to give EPA as much time as possible to process your request.

ADDRESSES: The meeting will be held at Conference Center, Lobby Level, One Potomac Yard (South Bldg.), 2777 S. Crystal Dr., Arlington, VA.

FOR FURTHER INFORMATION CONTACT: Elizabeth Leovey, Immediate Office, 7501P, Office of Pesticide Programs, Environmental Protection Agency, 1200 Pennsylvania Ave., NW., Washington, DC 20460–0001; telephone number: (703) 305–7328; fax number: (703) 308–4776; e-mail address: *leovey.elizabeth@epa.gov.*

SUPPLEMENTARY INFORMATION:

I. General Information

A. Does this Action Apply to Me?

This action is directed to the public in general, and may be of particular interest to persons who are concerned about implementation of the Pesticide Registration Improvement Act (PRIA), the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and the Federal Food, Drug, and Cosmetic Act (FFDCA). Other potentially affected entities may include but are not limited to agricultural workers and farmers; pesticide industry trade associations; environmental, consumer and farmworker groups; pesticide users and growers; pest consultants; State, local and tribal governments; academia; public health organizations; food processors; and the public. Since other entities may also be interested, the Agency has not attempted to describe all specific entities that may be affected by this action. If you have any questions regarding the applicability of this action to a particular entity, consult the person listed under **FOR FURTHER INFORMATION CONTACT.**

B. How Can I Get Copies of this Document and Other Related Information?

1. *Docket.* EPA has established a docket for this action under docket identification (ID) number EPA–HQ–OPPT–2007–0191. Publicly available docket materials are available either in the electronic docket at *http://www.regulations.gov*, or, if only available in hard copy, at the Office of Pesticide Programs (OPP) Regulatory Public Docket in Rm. S–4400, One Potomac Yard (South Bldg.), 2777 S. Crystal Dr., Arlington, VA. The hours of operation of this Docket Facility are from 8:30 a.m. to 4 p.m., Monday through Friday, excluding legal holidays. The Docket Facility telephone number is (703) 305–5805.

2. *Electronic access.* You may access this **Federal Register** document electronically through the EPA Internet under the "**Federal Register**" listings at *http://www.epa.gov/fedrgstr.*

II. Background

The Office of Pesticide Programs (OPP) is entrusted with the responsibility of ensuring the safety of the American food supply, protection and education of those who apply or are exposed to pesticides occupationally or through use of products, and the general protection of the environment and special ecosystems from potential risks posed by pesticides. The PPDC was established under the Federal Advisory Committee Act (FACA), Public Law 92-463, in September 1995 for a 2–year term and has been renewed every 2 years since that time. The PPDC provides advice and recommendations to OPP on a broad range of pesticide regulatory, policy, and program implementation issues that are associated with evaluating and reducing risks from the use of pesticides. The following sectors are represented on the PPDC: Pesticide industry and trade associations; environmental/public interest and consumer groups; farm worker organizations; pesticide user, grower and commodity groups; Federal and State/local/Tribal governments; the general public; academia; and public health organizations. Copies of the PPDC charter are filed with appropriate committees of Congress and the Library of Congress and are available upon request. Copies of the minutes of past meetings of this workgroup are available on the internet at *http://www.epa.gov/pesticides/ppdc/pria/index.html.*

III. How Can I Request to Participate in this Meeting?

This meeting will be open to the public and seating is available on a first-come basis. Persons interested in attending do not need to register in advance of the meeting. Opportunity will be provided for questions and comments by the public. Any person

Broach, Joy I LRN

From: Broach, Joy I LRN On Behalf Of Repair, CenterHill LRN
Sent: Thursday, September 06, 2007 3:22 PM
To: Johnson, Peter
Cc: Adcock, Linda H LRN; Dunn, Tim D LRN
Subject: RE: Comments Of Center hill Lake & Dam Repair

Dear Mr. Johnson,

Your comments are appreciated. They will be considered in the final decision.

Sincerely,

Joy Broach

Joy Broach, Biologist
US Army Corps of Engineers
P.O. Box 1070 (PM-P)
801 Broadway
Nashville, TN 37202-1070

Phone: 615-736-7956 Fax: 615-736-2052
Joy.I.Broach@lrn02.usace.army.mil

-----Original Message-----
From: Johnson, Peter [mailto:Peter.Johnson@53.com]
Sent: Wednesday, September 05, 2007 2:21 PM
To: Repair, CenterHill LRN
Subject: Comments Of Center hill Lake & Dam Repair

To Whom it may concern,

After reading the article and subsequent over 200 pg PDF environmental impact statement I felt it necessary to comment.

I am a relatively new resident (Jan/07) of Blue Water Bay which resides in Smithville TN over looking Holmes Creek on Center hill lake.

I am an active recreational user of the lake, Boating, Swimming, Fishing,etc.. I own a slip at a neighboring marina for my boat.

After reading the 'PDF' I do fully understand that repairs need to be made to protect the lake and entire area.

I believe that of the 9 different scenarios/alternatives given within the statement. In my opinion Alternative #4 (four) would be the best solution.

As it still allows for very good safety as well as day to day usage of the lake. Reviewing the current pool levels of the lake and it being a 'very' dry summer. Current pool levels have averaged just about on target with this option.

I believe this has had a minimal impact on the surrounding communities from my observations and discussions with local residents.

I fully hope all residents and anyone interested will have some say in your(The Corps) decision.

I would like to be notified of any additional meetings and information pertaining to this project.

Please feel free if possible to email or snail mail me this information.

Thank you very much for reading this and listening to my thoughts.

Best regards,

Pete Johnson

[redacted]
Smithville, TN 37166

Broach, Joy I LRN

From:	Broach, Joy I LRN on behalf of Repair, CenterHill LRN
Sent:	Thursday, October 18, 2007 3:29 PM
To:	Brenda Tucker; Repair, CenterHill LRN
Cc:	Dunn, Tim D LRN; Adcock, Linda H LRN
Subject:	RE: CONCERNED

Dear Ms. Tucker,

Thank you for your patience. Inundation (flood) maps were finalized over recent months and were provided to emergency management personnel for evacuation planning in October 2007. In the unlikely event of a dam failure, flooding would generally be along low lying areas along the Caney Fork River and its tributaries. The area around Silver Point is above the area of flooding. You may also wish to view the maps by contacting your local emergency manager. The DeKalb County Emergency Manager is Charlie Parker, phone number 615-597-5673. Over the next few months the Corps will coordinate and plan public meetings in potentially affected areas. We will advertise the time and location in advance. In the meanwhile, you may access the Corps' website for additional information about Center Hill Dam. The address is: http://www.lrn.usace.army.mil/CenterHill

Sincerely,

Joy Broach, Biologist
US Army Corps of Engineers
P.O. Box 1070 (PM-P)
801 Broadway
Nashville, TN 37202-1070

Phone: 615-736-7956 Fax: 615-736-2052

-----Original Message-----
From: Brenda Tucker [mailto:bkay8218@yahoo.com]
Sent: Monday, September 10, 2007 8:18 PM
To: Repair, CenterHill LRN
Subject: CONCERNED

I WOULD LIKE TO KNOW WHAT AREAS WOULD BE AFFECTED IF THE DAM WAS TO BREAK? COULD YOU PLEASE E-MAIL ME AND LET ME KNOW. I LIVE IN THE SILVER POINT AREA. THANK YOU BRENDA T.

Broach, Joy I LRN

From:	Broach, Joy I LRN on behalf of Repair, CenterHill LRN
Sent:	Thursday, October 18, 2007 3:35 PM
To:	Hwy 56 Storage
Cc:	Dunn, Tim D LRN; Adcock, Linda H LRN
Subject:	RE: Center Hill Dam

Dear Ms. Schoenmann,

Thank you for your patience. Inundation (flood) maps were finalized just recently (October 2007) and were provided to emergency management personnel for evacuation planning. In the unlikely event of a dam failure, the Corps would initially notify the National Weather Service to begin notification on televisions, radios and weather radios. Flooding would generally be along the Caney Fork River and its tributaries. Smithville is above the dam with no flooding potential; however, loss of water supply is a potential impact of dam failure. Gordonsville is along the Caney Fork and could experience flooding. The County Emergency Managers would coordinate with the schools for evacuation.

At this time we have only provided the maps to the County Emergency Managers (EMs) You may wish to contact these local emergency managers to discuss the plan, to see the maps, and to learn how to best prepare your family. The DeKalb County EM is Charlie Parker, phone number 615-597-5673 and the Smith County EM is Sonny Carter, phone number 615-735-8218. Over the next few months the Corps will coordinate with the County EMs and plan public meetings in potentially affected areas. We will advertise the time and location in advance. We will also notify you through email. The inundation maps will be available at the public meetings also. In the meanwhile, you may access the Corps' website for additional information about Center Hill Dam. The address is: http://www.lrn.usace.army.mil/CenterHill

We appreciate your questions.
Sincerely,

Joy Broach, Biologist
US Army Corps of Engineers
P.O. Box 1070 (PM-P)
801 Broadway
Nashville, TN 37202-1070

Phone: 615-736-7956 Fax: 615-736-2052

-----Original Message-----
From: Hwy 56 Storage [mailto:hwy56storage@dtccom.net]
Sent: Tuesday, September 11, 2007 9:14 AM
To: Repair, CenterHill LRN
Subject: Center Hill Dam

Hello, I live in Smithville and have family in Alexandria, my grand children goes to Gordonsville Elementary School. My question is will Alexandria be affected if the dam breaks? Also will Gordonsville be affected and if so how long will people have to get out? Aslo will Smithville be affected in any way? How will the corps alert people thet they need to leave... . I know alot of questions............ But I need to know what I need to do on this end to be prepared to help them and if I'd be able to help them. I'd appreciate you help on this matter. Also will you be posting a map on the web showing what area's will be affected?
Thank you,
Sheila Schoenmann

September 18, 2007

Ms. Joy Broach
Project Planning Branch
U.S. Army Corps of Engineers
P O Box 1070
Nashville, TN 37202-1070

RE: Draft Environmental Impact Statement
Changes to Center Hill Lake Elevations
Center Hill Dam and Lake
Dekalb County, Tennessee
U S Army Corps of Engineers
August 2007

Dear Ms. Broach:

Please accept this letter as formal comment by the City of Smithville regarding the subject document. The City of Smithville owns and operates a multiport raw water intake structure located adjacent to Center Hill Lake. This intake is the sole source of water for the City of Smithville and the Dekalb County Utility District, our largest customer. The intake was constructed in 1967.

The engineering company that designed this structure still serves as our consultant and according to their calculations, the absolute minimum lake elevation which will allow this intake to function hydraulically is elevation 618.0 MSL. However, they have cautioned us that lake elevations below 620.0 MSL could cause turbulence in our pump well possibly affecting the pumps. In addition, our water treatment plant operators report that lake elevations below 623.5 MSL result in poor raw water quality which creates treatment difficulties. For these reasons, we prefer that Corps of Engineers maintain the elevation of Center Hill Lake at elevation 623.5 or above but understand the importance of Dam repair. If the lake surface is dropped below elevation 620.0, our pumps may begin to cavitate and malfunction which will result in the City being out of water.

Thank you for your consideration and please keep me advised of developments regarding this project.

Yours very truly,

CITY OF SMITHVILLE, TENNESSEE.

Taft Hendrixson

Taft Hendrixson
Mayor

cc: J. Greg Davenport, P.E., J. R. Wauford and Company, Consulting Engineers, Inc.

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
WATER SUPPLY
9th Floor, 401 Church Street
Nashville, Tennessee 37243-1549
Phone: (615) 532-0191; Fax: (615) 532-0503

September 18, 2007

William R. Barron Jr., P.E.
Acting Chief, Project Planning Branch
Department of the Army
Nashville District, Corps of Engineers
P.O. Box 1070
Nashville, Tennessee 37202-1070

RE: Draft Environmental Impact Statement (DEIS) Center Hill Dam Lake, DeKalb County, Tennessee, Changes to Center Hill Lake Elevations, August 2007.

Mr. Barron:

The Division of Water Supply has received and reviewed the request for comments on the Draft Environmental Impact Statement (DEIS) Center Hill Dam Lake, DeKalb County, Tennessee, Changes to Center Hill Lake Elevations, August 2007 and would like to thank the Nashville District, Corps of Engineers for the opportunity to comment on this plan.

The Division of water Supply is charged with protecting the citizens of Tennessee by ensuring that all public water supply systems provide for their customers potable drinking water. The protection of these water sources is a high priority for this Division. In order to ensure adequate supplies of water for treatment the Division of Water Supply would like to make comments on the proposed lake levels and their potential affect on the drinking water supply for over 60, 000 citizens of the State of Tennessee.

In section 4.16. titled Water Supply (pages 62-63) in the DEIS the Corps proposes nine alternatives for lake drawdown. The Division would like to make the following statements about each of the alternatives:

Alternative 1 (EL 648.0/623.5) No Action: the Division does not wish to see the dam removed or destroyed therefore some actions must be taken to preserve this water supply source.

Alternative 2 (EL 645.0/623.5) from a water supply standpoint this would allow all water systems in the lake to continue to operate at full capacity but does not provide a long term solution to the situation.

Alternative 3 (EL 640.0/623.5) from a water supply standpoint this would allow all water systems in the lake to continue to operate at full capacity but does not provide a long term solution to the situation.

Alternative 4 (EL 635.0/623.5) from a water supply standpoint this would allow all water systems in the lake to continue to operate but at a reduced capacity and with modifications to the water treatment process.

Alternative 5 (EL 630.0/618.0) Smithville Water System and Cookeville Water Department operations would be drastically changed at this level. At the current locations of the intakes any drop of water level below an estimated 623 elevation would cause the pumps to suck air and possibly damage impellors and other equipment. The water systems would require modifications to the pumps and the capacity to produce enough water to supply the customers. This level would also require additional monitoring and treatment processes.

Alternative 6 (EL 625.0/623.5) Smithville Water System and Cookeville Water Department operations would be drastically changed at this level. At the current locations of the intakes any drop of water level below an estimates 623 elevation would cause the pumps to suck air and possibly damage impellors and other equipment. The water systems would require modifications to the pumps and the capacity to produce enough water to supply the customers. This level would also require additional monitoring and treatment processes.

Alternative 7-9 From a water supply standpoint these elevations are not acceptable and would cause substantial harm to the water system and their customers.

The Division of Water Supply continues to look forward to conversations about the proposed repair of the dam itself. The Underground Injection Control (UIC) Program will continue to be of assistance with your personnel as they develop different strategies for the grouting of the karst features around the dam. There are two water systems that are below the dam that we are concerned about if the materials used in the repair of the dam should happen to reach these smaller water systems.

These are the Smith County Utility District and the Carthage Water System. The Division will work with the engineers and others on your staff as a repair method is finalized to ensure the protection of these systems.

The Division requests that before any alternative is chosen that the Corps of Engineers and personnel from this Division and the operators from the Cookeville Water Department, the Smithville Water System, Smith County Utility District, and Carthage Water System have an opportunity to meet and discuss possible changes and their effect on the water systems and a time frame for alterations to be made to any water system that may be affected.

This letter represents a brief review off best available data sources and not a comprehensive field evaluation. Please verify all information contained within this letter in the field.

If you have any questions, feel free to call me at (615) 532-9224 or email at scotty.sorrells@state.tn.us.

Sincerely,

Scotty D. Sorrells
Manager Ground Water Management Section
Source Water Protection Coordinator
Division of Water Supply

c: Thomas A. Moss Deputy Director DWS

Broach, Joy I LRN

From: Broach, Joy I LRN on behalf of Repair, CenterHill LRN
Sent: Thursday, October 18, 2007 3:40 PM
To: Bob Richie
Cc: Dunn, Tim D LRN; Adcock, Linda H LRN
Subject: RE: Report on dam

Dear Mr. Richie,

Thank you for your comments. The Corps does not have a shortened version of the Draft Environmental Impact Statement. However, answers to your questions may be found on the Corps website at: http://www.lrn.usace.army.mil/CenterHill/Q&A.htm. For over a year, the Corps has been working with the Tennessee Emergency Management Agency, County and City Emergency Responders, regarding public safety in the unlikely event of a sudden dam failure. The emergency personnel and the Corps will work together to get information to the citizens, through public meetings or visits to the local emergency office. The Corps plans to begin Center Hill public meetings later in the year and will post public notification of meetings on the website. We would be glad to meet with your church group during the week if that is possible. Please contact me if this is desired.

We appreciate your patience.
Sincerely,

Joy Broach, Biologist
US Army Corps of Engineers
P.O. Box 1070 (PM-P)
801 Broadway
Nashville, TN 37202-1070

Phone: 615-736-7956 Fax: 615-736-2052

-----Original Message-----
From: Bob Richie [mailto:Bob.Richie@state.tn.us]
Sent: Wednesday, September 19, 2007 10:07 AM
To: Repair, CenterHill LRN
Subject: Report on dam

While this is a nice report on dam, do you not produce a shorten 10 page one on the effects to those downstream? Or do you have a separate paper written?

Can you do a session at our men's church breakfast? we meet the 4th Sunday of the month at 8 AM at Hermitage Presbyterian Church.

Thank you.

Bob Richie

Broach, Joy I LRN

From: Broach, Joy I LRN on behalf of Repair, CenterHill LRN
Sent: Thursday, October 18, 2007 3:45 PM
To: Michael Moon
Cc: Dunn, Tim D LRN; Adcock, Linda H LRN
Subject: RE: Realestate At Center Hill Lake

Dear Mr. Moon,

The Corps is currently evaluating proposals from contractors to begin construction on the more critical areas of the main dam embankment (earthen portion) and the left rim. This grouting contract is scheduled to begin in 2008. Additional grouting and cut-off walls are planned through 2014. In the meanwhile, we will continue to closely monitor the dam. We believe our repair is a timely one well in advance of emergency conditions. The lake; however, will be kept somewhat lower than normal until enough repair has been accomplished to safely allow normal levels to resume. The Corps will use news articles, websites, and public meetings to keep the public informed of the dam's condition and of progress of the foundation remedy throughout construction.

Thank you for your patience.

Sincerely,

Joy Broach, Biologist
US Army Corps of Engineers
P.O. Box 1070 (PM-P)
801 Broadway
Nashville, TN 37202-1070

Phone: 615-736-7956 Fax: 615-736-2052

-----Original Message-----
From: Michael Moon [mailto:moon8466@comcast.net]
Sent: Saturday, September 22, 2007 9:07 AM
To: Repair, CenterHill LRN
Subject: Realestate At Center Hill Lake

I am going to look at property on Center Hill lake next Saturday and would like to know the status of the dam and its repairs. Any information would be greatly appreciated to help us decide on whether to buy or not.

Thanks,

Mike Moon

DATE: September 25, 2007

TO: Mr. Stephen Beason
Department of the Army
Nashville District, Corps of Engineers

FROM: Alan Sielbeck
Hurricane Marina

RE: Potential Operations Impact from Lower Lake Levels – Center Hill Lake

Dear Mr. Beason:

We have made a preliminary evaluation of the issues that Hurricane Marina must address if the Corps should drop the lake level to approximately elevation 618', as assumed in Alternatives 5 and 7 of the US Army Corps of Engineers Draft Environmental Impact Statement dated August, 2007. Our assessment is as follows:

We have prepared a fairly detailed map of our harbor as it would look at elevation 618'. At that level, we would have to reposition all 4 piers (A,B,C and D) of our Historic District as well as all 6 piers (E,F,G,H,J,K) of our new sections, including the ship store and restaurant facility. The changes would impact all 580 of our existing slips.

We believe the new sections (E,F,G,H,J and K piers) can be relocated approximately 30ft toward the lake channel to provide minimal clearances for flotation of the slips as well as minimal clearances for boat traffic to utilize the harbor and marina facilities. Most of our existing winches and cables/anchors can remain in place but we would expect to have to replace approximately 25-30 cables and anchors to accommodate this move. The existing land side bridge would have to be disconnected and relocated to a new landing on the main walkway. The access bridge angle would be at a very undesirable steep grade (probably in excess of 15% and borderline unusable). It is our opinion that gasoline lines, electric service lines, sanitary sewer lines, telephone service lines and propane gas lines can handle this relocation without major rework. Our water line servicing the new piers would have to be lengthened. For safety reasons, I would expect to have to close access to this section of the marina for a few days to make these changes. We would have to coordinate this work with an outside contractor such as the original dock builder (Atlantic-Meeco) to make these modifications. A rough estimate of the relocation cost to the new sections of the marina is approximately $70,000 to $100,000.

The Historic District (A,B,C and D piers) would be severely impacted. Piers A, C and D would have to be taken apart and shortened by approximately 75-100ft each. In addition, all 4 piers would then have to be relocated approximately 70ft away from the existing parking lot side of the harbor. This would require lengthening the main walkway by 70 ft as well as lengthening the water and electric service lines feeding these 4 piers. The disconnected portions of Piers A,C and D would have to either be abandoned (most likely scenario) or possibly relocated to the end of G Pier in the new section of the marina. All winch cables and anchors would have to be replaced and reset. Even with this major realignment, boats on Piers A and B would likely not be able to exit the marina until water levels returned to approximately 623'. The extensive rework required in the Historic District would require this section of the marina to be closed to the public and our tenants for several weeks.

A rough estimate of the relocation cost for the Historic District is approximately $150,000 to $200,000 in addition to the permanent loss of revenue from the abandoned slips and the potential loss of revenue of many existing "stranded" slip tenants currently on Piers A and B.

While these changes can be made, I must stress that we can not "fix" the damage to our tenants and visitors as a result of a drastic lake draw down to elevation 618'. At that level, we are a very poorly designed and very difficult marina to use. The premier marina on Center Hill Lake would become a third class marina, barely functional. Our original design for the relocation and expansion of the old existing Hurricane Marina anticipated a low lake level of approximately 623' – commensurate with the last 30 years or so of Corps management history. At 623' or above, we are a first class, fully functional marina with good navigation and ample safety margins for boat traffic and underwater service lines.

We have invested in excess of $10 million dollars to date in Hurricane Marina and have developed a world-class facility that our customers love. Our 100% occupancy and large waiting list is a testament to the terrific boating experience provided by Center Hill Lake and Hurricane Marina. To continue to deliver that world-class experience, we need a lake level of 623' or greater. With our current facility, we have great flexibility in the summer pool levels and can deliver an excellent product with excellent service and access at most any lake level in winter or summer from 623' to >670'.

In Summary:

Based on the Draft Environmental Impact Statement Dated August 2007 prepared by the US Army Corps of Engineers, of all the 9 Alternatives evaluated, **the Corps' Environmentally Preferred Alternative 4 is also our strong preference.**

Most of our marina operations are protected by Alternatives 1,2,3,4 or, though less desirable, even Alternatives 6 and 8. Alternatives 5 and 7 are very difficult due to the lower lake guideline of 618' assumed in those two alternatives and would drastically impact our ability to function. The upper end guidelines of Alternatives 5 and 7 are not problematic. Alternative 9 would compare us favorably to the Ninth Ward of New Orleans.

Thank you for allowing us a forum to address the potential impact on our existing marina operations. Hurricane Marina is proud to be a part of the recreational experience provided by Center Hill Lake and the Corps of Engineers. We appreciate and respect the tremendous responsibility the Corps has in remediating the seepage issues with the dam.

USDA United States Department of Agriculture | Forest Service | Daniel Boone National Forest | 1700 Bypass Road Winchester, KY 40391 859-745-3100

File Code: 1950-4
Date: OCT 2 2007

William R. Barron, Jr., P.E.
Acting Chief, Project Planning Branch
Department of the Army
Nashville District, Corps of Engineers
P.O. Box 1070
Nashville, TN 37202-1070

Dear Mr. Barron:

Thank you for the opportunity to review the Draft Environmental Impact Statement for repairs to the Center Hill Dam and Lake in DeKalb County, Tennessee. Activities as proposed will not impact resources or programs on National Forest System lands on the Daniel Boone National Forest. Additional coordination with my office, as it relates to this proposal, is not necessary.

Sincerely,

JEROME E. PEREZ
Forest Supervisor

Broach, Joy I LRN

From: Broach, Joy I LRN on behalf of Repair, CenterHill LRN
Sent: Tuesday, October 30, 2007 12:34 PM
To: Gregory_Hogue@ios.doi.gov
Cc: Adcock, Linda H LRN; Dunn, Tim D LRN
Subject: RE: DEIS for Center Hill Dam and Lake

Dear Mr. Hogue,
Your comments have been received and will be included in the Final EIS for Center Hill Dam and Lake.

Your time and effort are appreciated,
Sincerely,

Joy Broach

Joy Broach, Biologist
US Army Corps of Engineers
P.O. Box 1070 (PM-P)
801 Broadway
Nashville, TN 37202-1070

Phone: 615-736-7956 Fax: 615-736-2052
Joy.I.Broach@lrn02.usace.army.mil

-----Original Message-----
From: Gregory_Hogue@ios.doi.gov [mailto:Gregory_Hogue@ios.doi.gov]
Sent: Wednesday, October 17, 2007 7:49 AM
To: Repair, CenterHill LRN
Cc: Lloyd_H_Woosley%USGS@ios.doi.gov
Subject: DEIS for Center Hill Dam and Lake

Attached are the Department of the Interior's comments to the subject DEIS.

Gregory Hogue
Regional Environmental Officer
Department of the Interior
Ofc of Environmental Policy & Compliance
75 Spring St., SW, Rm 1144
Atlanta, GA 30303
404-909-0537 (24HR)
404-331-4524 (ofc)
404-331-1736 (FAX)

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Richard B. Russell Federal Building
75 Spring Street, S.W.
Atlanta, Georgia 30303

TAKE PRIDE IN AMERICA

ER 07/741
9043.1

October 17, 2007

Ms. Joy Broach
Nashville District
Army Corps of Engineers
PO Box 1070
Nashville, TN 37202-1070

RE: Draft Environmental Impact Statement for Center Hill Dam and Lake, Changes to Center Hill Lake Elevations, Dekalb County, TN

Dear Ms. Broach:

The Department of the Interior has reviewed the referenced draft environmental impact statement (DEIS) and offers the following comments.

Section 4.6, Aquatic Resources, and Section 4.11, Threatened and Endangered Species, pages 53-58

According to the DEIS, (page 54) under the environmentally preferred alternative (Alternative 4), "Center Hill Lake would sustain current fish and mussels with some minimal impact." However, the document goes on to say that (page 56) "during a wet year, high warm inflows could partially mix in the hypolimnion" and that "even with minimum flow and adequate DO [dissolved oxygen], warmer water for a sustained length of time would stress trout and potentially be lethal." Consideration should be give to potential mitigative actions that could help avoid or minimize such impacts.

The DEIS references the August 2007 Biological Assessment (BA) included in Appendix A and states that (page 59) under the environmentally preferred alternative (Alternative 4), "impacts would be minimal to listed species since these elevations routinely occur under normal lake operations." The final EIS could be improved if it included a holistic analysis of how the impacts on aquatic resources may affect the listed species from trophic level interactions, as well as proposed mitigation measures based on available scientific studies with supporting references. For instance, the BA states (Appendix A, pages 20 and 21-22, respectively) that "a slight decrease in water quality in the form of increase temperatures and lowered DO would not affect the [interior] least tern" and that those conditions also"… would not affect the gray bat." These two species' food sources include aquatic species. There is no discussion in the BA or DEIS related to how the potential impacts from proposed dam activities could indirectly affect these species, nor a discussion of possible mitigation actions.

If you have any questions concerning these comments, please contact Lloyd Woosley, Chief of the US Geologic Survey Environmental Affairs Program, at 703-648-5028 or at LWOOSLEY@USGS.GOV.

Sincerely,

Gregory Hogue
Regional Environmental Officer

cc:
LWoosley, USGS-Reston, VA
OEPC, Washington

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
WATER POLLUTION CONTROL
401 CHURCH STREET
6TH FLOOR L&C ANNEX
NASHVILLE, TN 37243

October 16, 2007

Ms. Joy Broach
Attn: CELRN-PM-P
Department of the Army
Nashville District, Corps of Engineers
P.O. Box 1070
Nashville, Tennessee 37202-1070

SUBJECT: Center Hill Dam, DeKalb County
Draft Environmental Impact Statement, Changes to Center Hill Lake Elevations

Dear Ms. Broach:

Thank you for your recent request for preliminary information on the above referenced proposed DEIS in DeKalb County, Tennessee, relative to any potential environmental impacts or concerns the Division of Water Pollution Control (Division) may have.

Our main concerns with the lowered elevation in Center Hill Lake include the effects on water quality throughout the Caney Fork River and the designated uses of the waterway including fish & aquatic life, livestock watering and wildlife, and irrigation.

Please understand that there may be other regulatory programs applicable to this project that are administered by other divisions of the Department of Environment and Conservation. The applicant
is responsible to determine all regulatory programs that are applicable to this project. This letter is intended to give information on this Division's regulatory role in the process and to provide guidance on possible impacts to waters of the state. It is **not** a complete evaluation of all potential environmental impacts that this project could have on the affected watersheds. A complete evaluation of the proposed project will be done when detailed plans and permit applications are submitted to the Division.

If you have any questions regarding these comments, please contact Rob Howard at (931) 432-7632.

Sincerely,

Regan McGahen (gaw)

Regan McGahen
Environmental Specialist
Division of Water Pollution Control

cc: File
Mary Parkman, TDEC - Office of General Counsel
Rob Howard, Water Pollution Control, Cookeville EFO

TENNESSEE WILDLIFE RESOURCES AGENCY

ELLINGTON AGRICULTURAL CENTER
P. O. BOX 40747
NASHVILLE, TENNESSEE 37204

October 17, 2007

Joy Broach
Project Planning Branch
U.S. Army Corps of Engineers
P.O. Box 1070
Nashville, TN 37202-1070

Dear Ms. Broach:

The Tennessee Wildlife Resources Agency (TWRA) has received and reviewed information that you sent to us regarding the Draft Environmental Impact Statement – "Changes to Center Hill Lake Elevations, Center Hill Dam and Lake, Dekalb County, Tennessee." We recommend and support Alternative 4. Environmentally Preferred Alternative.

Thank you for the opportunity to review and comment on this Draft Environmental Impact Statement.

Sincerely,

Robert M. Todd
Fish and Wildlife Environmentalist

Department of Energy
Southeastern Power Administration
Elberton, Georgia 30635-6711

October 17, 2007

Ms. Joy Broach
Project Planning Branch
Nashville District, Corps of Engineers
P.O. Box 1070
Nashville, TN 37202-1070

Dear Ms. Broach:

Southeastern Power Administration (Southeastern) would like to take the opportunity to provide comments regarding the Nashville District's Draft Environmental Impact Statement (DEIS) "Changes to Center Hill Lake Elevations," dated August 2007. From our review of this information, it is very apparent that, like Wolf Creek, Center Hill has become a significant safety concern with respect to the possibility of a structural failure occurring at the facility. Southeastern would encourage the District to implement an operational plan and take any actions deemed appropriate to protect both life and property from the possibility of a failure of the facility and the ensuing loss of the project's reservoir.

Implementation of the recommended alternative, Alternative 5, will reduce available generation, scheduling flexibility, and ultimately the value of the peaking resource at Center Hill; however Southeastern remains committed to working with the Nashville District to realize the value of any possible benefits remaining for hydropower under this alternative.

As the remedial work at the project gets underway, Southeastern would strongly encourage the District to explore opportunities to expedite the repair process if at all possible, such that the currently planned seven to ten year construction period could be shortened so that a traditional peaking hydropower operation could resume in an earlier timeframe. In addition, Southeastern would once again encourage the District to assign the estimated $240 million dollar costs associated with the repairs to dam safety. Based on the criticality and concern regarding the safety of the facility, we believe this would be the most appropriate course of action.

We at Southeastern look forward to continuing to work with the Nashville District on this important issue. If you have any questions, please call me at (706) 213-3850.

Sincerely,

Kenneth E. Legg
Assistant Administrator
for Power Resources

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

October 23, 2007

Joy Broach
Project Planning Branch
U.S. Army Corps of Engineers, Nashville District
P.O. Box 1070
Nashville, Tennessee 37202-1070

SUBJECT: Draft Environmental Impact Statement for Center Hill Dam and Lake Project to Revise Operational Guide Curves and Pool Elevations in Dekalb County, Tennessee; CEQ Number 20070377

Dear Ms. Broach:

The U.S. Environmental Protection Agency (EPA) has reviewed the referenced Draft Environmental Impact Statement (EIS) in accordance with its responsibilities under Section 309 of the Clean Air Act and Section 102(2)(C) of the National Environmental Policy Act (NEPA). The Center Hill Project, owned and operated by the U.S. Army Corps of Engineers (USACE), is located on the Caney Fork River in DeKalb County, Tennessee. The Center Hill Dam is a combination earthen fill and concrete structure 2,160 feet long and 250 high. The average discharge from the dam is approximately 3,800 cubic feet per second (cfs). Center Hill Lake, created by the dam, has a drainage area of 2,174 square miles and a surface area of 18,220 acres.

Since construction of the dam in 1951, the concrete and earthen embankments have been plagued with increasing seepage problems. To address these problems, the USACE developed specific dam repair and remediation projects in 2005 and 2006. An Environmental Assessment (EA) was completed for each of these projects. At the time, no significant changes to the normal pool elevations were considered necessary. However, the repairs identified will take a number of years to complete and the risk of potential dam failure will increase during this time. Therefore as a proactive measure, the USACE proposes to evaluate different interim lake elevations to reduce the hydrostatic pressure and potential risk of dam failure. The purpose of the EIS is to analyze possible impacts resulting from interim pool elevation alternatives and an unscheduled emergency drawdown that could occur during 7-10 years of repairs to the dam. When repairs are complete, Center Hill Dam and Lake would return to normal operations.

Lake levels at Center Hill Lake have historically been managed in accordance with the Center Hill Project Guide Curve. This operations guidance divides the lake into distinct pools (layers) based on three congressionally-authorized elevations (EL 685, 648, and 618) which form boundaries for project operations throughout the year. The bottom layer of Center Hill Lake is the inactive storage pool (from the bottom of the reservoir up to EL 618). The next zone is the power pool, which is a 30-foot "normal operating zone" between EL 618 and 648. This is the zone in which water is stored for hydropower and other project purposes. The flood control pool extends from EL 648 to EL 685. The normal condition is for this pool to remain empty so that space is available for flood water storage. Overall normal project operations have historically followed a guide curve within a "Power Marketing Band" (PMB), which falls within the power pool and represents the optimal range for power generation. The normal summer pool elevation is EL 648, and the normal winter pool elevation is EL 623.5. However, the USACE has recently modified operations to manage the lake levels at a normal maximum pool elevation of EL 640, aggressively adhering to the bottom of the PMB to reduce the risk of dam failure. For the purposes of the Draft EIS, this is considered the no action alternative. A total of nine interim pool elevation alternatives (e.g., temporary operating bands or guide curves) were evaluated in the Draft EIS, ranging from maintaining Center Hill Lake at normal levels to an emergency drawdown to EL 496. No overall preferred alternative was identified.

In general, EPA supports the purpose and need for the action proposed in the Draft EIS. EPA understands that lake levels must be managed as part of dam remediation activities to first and foremost maintain public safety and minimize the risk of dam failure. However, EPA has environmental concerns with some of the alternatives related primarily to water quantity and water quality in the reservoir and project dam releases. To assist in the identification of a preferred alternative, EPA requests additional risk assessment information related to the difference in dam failure risk for each of the proposed alternatives. EPA offers the following specific comments for your consideration in development of the Final EIS for this project:

Alternatives

EPA is unclear of some of the terminology associated with a few of the alternatives. Alternative 1 is described as the "normal operating band," i.e., how the lake has historically been operated. It is assumed that after repairs are complete, the lake would once again resume "normal" operations as described in Alternative 1. Since the purpose of the project is to develop interim lake levels that deviate from normal operations, why is this alternative not considered the no action alternative? Alternative 3 is described as the "no action alternative." It is unclear why Alternative 3 would not be considered an action alternative, since it involves drawing the lake down below normal levels, and it has only been utilized as an operating approach since December 2006. Also, Alternative 4 is described as the "environmentally preferred alternative." However, the Draft EIS concludes that Alternative 4 would moderately to severely impact water quality, which in turn would negatively impact water supply and fisheries. The low water elevations could adversely affect fish spawning in the lake. How is this alternative considered environmentally preferred? Finally, Alternative 5 is described as the "Dam Safety and Engineering Preferred Alternative." Is this the USACE overall preferred alternative for managing lake levels during dam repairs? These issues should be explained and addressed in the Final EIS.

Water Quality/Water Quantity

EPA has environmental concerns related to implementation of lake levels (and downstream releases) associated with Alternatives 5 through 9. The Draft EIS states that Alternative 4 represents a breakpoint below which the negative environmental impacts of the alternatives change from predominately minor/moderate to moderate/severe, especially in the areas of water quality and fish and wildlife. EPA agrees with this assessment. At the lower operating bands, virtually all project purposes except for flood control would be moderately to severely impacted. Water quality, particularly dissolved oxygen (DO) and temperature, would become major concerns, especially in the project tailwaters. The fisheries both in the lake and in the tailwater would be stressed. Poor water quality together with algal and bacterial blooms would require additional processing by municipal water suppliers. From a recreation standpoint, many boat ramps would be unusable at various times of the year. If the USACE selects any of these alternatives, it appears that discharges from Center Hill Lake, downstream of the dam, will not meet state water quality standards for dissolved oxygen (DO) during mid to late summer. Therefore, EPA recommends immediate implementation of the mitigation measures described in Section 2.4 to ensure that discharges from the project meet state water quality standards. See additional comments on mitigation and monitoring below.

Water quantity is an important consideration for water supply and water quality. It is understood that lowering pool elevations would increasingly benefit flood storage; however, the availability of water quantity downstream and upstream of the Center Hill Project could be greatly reduced. Alternative 4 would supply approximately 54% of the water quantity minimally needed for all project uses, the system, and drought conditions. This drops off significantly in Alternatives 5 through 9. There is no discussion of the potential water supply impacts within the reservoir for Alternative 5 during the winter drawdown, similar to what is described for Alternative 7. In addition, there is no discussion of the potential impacts to the water supply intake located downstream of the dam for any of the alternatives. There is also no discussion of the potential impacts to the downstream municipal and industrial discharges into the Caney Fork River below the dam, as a result of reduced downstream flows from any of the alternatives. EPA recommends that the Final EIS include additional discussion of the water quantity and quality impacts.

Mitigation and Monitoring Measures

A number of potential mitigation measures are described in Section 2.4 for the Center Hill Project. It is unclear whether these measures are being proposed as part of this action or are existing commitments from other related dam remediation activities. For example, Section 2.4.1 references the potential installation of an orifice gate over a sluice gate to provide continuous minimum flows with high levels of dissolved oxygen (DO). However, other sections of the Draft EIS reference this as an existing commitment that includes installation and operation of an orifice gate in Fall 2007. Similarly, Section 2.4.2 references a release operations protocol that involves blending turbine and sluice gate discharges to ensure adequate DO is achieved in project discharges during the warmer summer months. However, Section 3.7 suggests that the USACE implemented this protocol in 2005.

EPA recommends that the Final EIS clearly identify the specific mitigation measures and any monitoring efforts that will be implemented at the Center Hill Project associated with the changes in lake elevations from dam remediation efforts. From a water quality standpoint, there is little information in the Draft EIS that describes current water quality monitoring associated with project. EPA supports an overall monitoring approach following completion of the EIS process that includes rigorous DO and temperature monitoring and a commitment to pursue additional DO enhancement measures based on the results of this monitoring. EPA is interested in water quality monitoring in the project area to determine compliance with state water quality standards, especially during this time of changing project conditions. Monitoring should be utilized to determine the impacts of the changes in lake elevations, associated flow releases, and other project changes on water quality. EPA recommends that the Final EIS include a project operations and flow monitoring plan that includes water quality monitoring to support such an objective, if this is not already in place.

From a cumulative impacts standpoint, since similar restrictions are being considered for Wolf Creek Dam and Lake Cumberland, EPA strongly recommends that the USACE develop interim changes to the operating protocols at other lakes in the Cumberland watershed to provide supplemental flows, as necessary, as described in Section 2.4.3. EPA also recommends that the USACE consider including a "mitigation" measure related to public outreach during this time of interim operations. This commitment could include more detailed, up-to-date monitoring information (reservoir levels, downstream flows, etc.) on a publicly available website to inform the public of current operations, the status of repairs, and any proposed changes to lake levels (immediate or longer-term) that are necessary as a result of dam distress monitoring. This would be a part of the adaptive management approach described below. These measures and a proposed implementation schedule should be included in the Final EIS.

Preferred Alternative

The Draft EIS states that the, "risk is reduced with each successive alternative." Therefore, it appears that the lower the reservoir levels, the lower the risk of dam failure. However, there is no information to inform the public or decisionmakers related to the degree of change in the risk for each of the alternatives. For instance, by how much would the risk of dam failure be reduced under each of the alternatives? EPA recommends that the Final EIS include more detailed risk analysis that considers alternative reservoir restriction levels coupled with the risk of dam failure/downstream consequences to better assist in selecting a preferred alternative of reservoir drawdown and operations restrictions.

Without any additional information to describe the risk of dam failure between the alternatives, EPA recommends that the USACE consider an aggressive adaptive management regime for managing lake levels during dam repairs, similar to how the system appears to be managed currently. Based on the information in the Draft EIS, it would appear that Alternative 3 should be selected as the initial preferred alternative, coupled with thorough monitoring and the ability to allow for deviations to lower lake levels based on the identification of distress indicators. Since going to the modified operating guide curve represented by Alternative 3, high peaks of pressure on the main and saddle dam foundations, earth embankments, and right and left rim walls have been markedly reduced. There has also been a documented reduction in the size of wet spots at the embankment toe and a marked decrease in the flows from the springs immediately below the dam that serve as seepage indicators. From this description, it would appear that the risk of dam failure has been significantly reduced by following the lake level operations protocol for Alternative 3.

The Draft EIS states that a Section 401 State Water Quality Certification or Aquatic Resources Alteration Permit will not be required for altering lake levels. Was this decision developed in consultation with the State of Tennessee? Given the potential for significant impacts to water quality, depending on which alternative is selected, EPA recommends that the USACE coordinate with the Tennessee Department of Environment and Conservation, Division of Water Pollution Control, prior to selection of the preferred alternative to ensure state water quality considerations are included in the final decision.

We rate this document EC-2 (Environmental Concerns – additional information requested). Enclosed is a summary of definitions for EPA ratings. We have concerns that the proposed action identifies the potential for impacts to the environment that should be avoided/minimized. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. We appreciate the opportunity to review the proposed action. Please contact Ben West of my staff at (404) 562-9643 if you have any questions or want to discuss our comments further.

Sincerely,

Heinz Mueller

Heinz J. Mueller, Chief
NEPA Program Office
Office of Policy and Management

cc: Tennessee Department of Environment and Conservation

U.S. ENVIRONMENTAL PROTECTION AGENCY
ENVIRONMENTAL IMPACT STATEMENT (EIS) RATING SYSTEM CRITERIA

EPA has developed a set of criteria for rating Draft EISs. The rating system provides a basis upon which EPA makes recommendations to the lead agency for improving the draft.

RATING THE ENVIRONMENTAL IMPACT OF THE ACTION

- LO (Lack of Objections): The review has not identified any potential environmental impacts requiring substantive changes to the preferred alternative. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposed action.

- EC (Environmental Concerns): The review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact.

- EO (Environmental Objections): The review has identified significant environmental impacts that should be avoided in order to adequately protect the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). The basis for environmental objections can include situations:

    1. Where an action might violate or be inconsistent with achievement or maintenance of a national environmental standard;
    2. Where the Federal agency violates its own substantive environmental requirements that relate to EPA's areas of jurisdiction or expertise;
    3. Where there is a violation of an EPA policy declaration;
    4. Where there are no applicable standards or where applicable standards will not be violated but there is potential for significant environmental degradation that could be corrected by project modification or other feasible alternatives; or
    5. Where proceeding with the proposed action would set a precedent for future actions that collectively could result in significant environmental impacts.

- EU (Environmentally Unsatisfactory): The review has identified adverse environmental impacts that are of sufficient magnitude that EPA believes the proposed action must not proceed as proposed. The basis for an environmentally unsatisfactory determination consists of identification of environmentally objectionable impacts as defined above and one or more of the following conditions:

    1. The potential violation of or inconsistency with a national environmental standard is substantive and/or will occur on a long-term basis;
    2. There are no applicable standards but the severity, duration, or geographical scope of the impacts associated with the proposed action warrant special attention; or
    3. The potential environmental impacts resulting from the proposed action are of national importance because of the threat to national environmental resources or to environmental policies.

RATING THE ADEQUACY OF THE ENVIRONMENTAL IMPACT STATEMENT (EIS)

- 1 (Adequate): The Draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

- 2 (Insufficient Information): The Draft EIS does not contain sufficient information to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the Draft EIS, which could reduce the environmental impacts of the proposal. The identified additional information, data, analyses, or discussion should be included in the Final EIS.

- 3 (Inadequate): The Draft EIS does not adequately assess the potentially significant environmental impacts of the proposal, or the reviewer has identified new, reasonably available, alternatives, that are outside of the spectrum of alternatives analyzed in the Draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. The identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. This rating indicates EPA's belief that the Draft EIS does not meet the purposes of NEPA and/or the Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised Draft EIS.

TVA

Tennessee Valley Authority, 400 West Summit Hill Drive, Knoxville, Tennessee 37902-1401

October 24, 2007

Ms. Joy Broach
Project Planning Branch
U.S. Army Corps of Engineers
Post Office Box 1070
Nashville, Tennessee 37202-1070

Dear Ms. Broach:

Enclosed are TVA's comments on the Draft Environmental Impact Statement (DEIS) for Changes to Center Hill Lake Elevations. After thoroughly reviewing the DEIS, we have concluded that Alternative 4 - Lake Elevations of 635.0 and 623.5, is our preferred alternative. We base this on the identification of Alternative 4 as the environmentally preferred alternative and on the statements in Table 3 and in Section 4.25 that the impacts on safety of Alternative 4 and Alternative 5 (Elevations of 630.0 and 618.0) are essentially the same.

Thank you for the opportunity to comment on this DEIS.

Sincerely,

Charles P. Nicholson

Charles P. Nicholson, Ph.D.
NEPA Policy Program Manager
Environmental Stewardship and Policy

Enclosure

Broach, Joy I LRN

From: Broach, Joy I LRN on behalf of Repair, CenterHill LRN
Sent: Tuesday, October 30, 2007 12:45 PM
To: Ronnie Kelly
Cc: Adcock, Linda H LRN; Dunn, Tim D LRN
Subject: RE: Draft Environmental Impact Statement Comments

Dear Mr. Kelly,

Thank you for your comments. They will be considered in the final decision. Your time and effort is appreciated.

Sincerely,

Joy Broach

Joy Broach, Biologist
US Army Corps of Engineers
P.O. Box 1070 (PM-P)
801 Broadway
Nashville, TN 37202-1070

Phone: 615-736-7956 Fax: 615-736-2052
Joy.I.Broach@lrn02.usace.army.mil

-----Original Message-----
From: Ronnie Kelly [mailto:rjk@cookeville-tn.org]
Sent: Thursday, October 25, 2007 2:44 PM
To: Repair, CenterHill LRN
Subject: Draft Environmental Impact Statement Comments

Ms. Joy Broach
Project Planning Branch
U.S. Army Corps of Engineers
P.O. Box 1070
Nashville, Tennessee 37202-1070:

The City of Cookeville has reviewed the Draft EIS "Changes to Operational Guide Curves Pool Elevations for Center Hill Lake" and offers the following comments.

Cookeville requests either Alternative 1, 2, 3, or 4 be chosen for future pool elevations during repairs to Center Hill Dam for the following reasons.

1. Cookeville's Water Plant successfully operated at these lower pool elevations last winter and can live with these elevations for a temporary period of time while the Dam repairs are completed. The lower elevations add additional cost to our rate payers due to the fact that for every foot of pool draw down below normal pool elevation we loose approximately 75,000 gallons per day pumping capacity.

2. Anything below the Alternative 4 low pool elevation will require Cookeville to turn on an additional pump to meet the normal water demand. The process of turning on this additional pump adds additional energy cost to the local rate payer. If this additional pump is engaged it leaves Cookeville without a back-up pump in the event of a pump failure. At a pool elevation of 618 Cookeville believes that it may not be able to meet the water demand for the City of Cookeville and the Upper Cumberland Region to which 50% of our water flow serves. For the above mentioned reasons Cookeville recommends against Alternative 5, 7, & 8.

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APPENDIX D

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DeKalb County, Tennessee

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APPENDIX E

LIST OF ACRONYMS

Center Hill Lake and Dam
DeKalb County, Tennessee

Acronyms and Abbreviations

BOD ....biological oxygen demand
CEN................Center Hill Dam
CEQ................Council On Environmental Quality
CFR ....Code of Federal Regulations
cfs...................cubic feet per second
COD ....chemical oxygen demand
Corps ..............U.S. Army Corps of Engineers
CRM...............Cumberland River Mile
CWA ....Clean Water Act
DAL ....Dale Hollow Dam
DCP................Drought Contingency Plan
DEIS...............Draft Environmental Impact Statement
DNA...............Division of Natural Areas
DO..................Dissolved Oxygen
DWS...............Division of Water Supply
EA ....Environmental Assessment
EIS..................Environmental Impact Statement
EL...................elevation mean sea level
EMS ....emergency management services
EOS ....Emergency Operations Schedule
EPA ................U.S. Environmental Protection Agency
ERGO.............Environmental Guide Review for Operations
ESA ....Endangered Species Act
FEIS ....Final Environmental Impact Study
fps...................feet per second
ft ....feet
FONSI ....Finding of No Significant Impact
FWCA ....Fish and Wildlife Coordination Act
gpm ....Gallons per minute
HTRW............hazardous, toxic and radiological waste
HUC ....Hydrologic Unit Code
IFIM ....instream flow incremental methodology
KFWR ....Kentucky Department of Fish and Wildlife Resources
LRD................Corps' Great Lakes and Ohio River Division
mg/L ....milligrams per liter
MSL ....mean sea level
MW ....megawatt

Acronyms and Abbreviations

NAAQS..........National Ambient Air Quality Standards
NED ....National Economic Development Plan
NEPA ....National Environmental Policy Act
NPDES...........National Pollutant Discharge Elimination System
NRCS .............U.S. Department of Agriculture, Natural Resource Conservation Service
OSHA.............Occupational Safety and Health Administration
PHABSIM......Physical Habitat Simulation System
PMB ....Power Marketing Band
ROD ....Record of Decision
SEPA..............South East Power Administration
TDEC ....Tennessee Department of Environment and Conservation
TMDL ....Total Maximum Daily Load
TVA ....Tennessee Valley Authority
TWRA............Tennessee Wildlife Resources Agency
USFWS ..........U.S. Fish and Wildlife Service
USGS .............U.S. Geological Survey
WOL ....Wolf Creek Dam
WPC...............Water Pollution Control