US Army Corps of Engineers

After Action Report

May 2010 Flood Event
Cumberland River Basin

1-3 May 2010

Great Lakes and Ohio River Division

21 July 2010

Table of Contents

EXECUTIVE SUMMARY 4
1.0 BACKGROUND 6
1.1 Purpose 6
1.2 Description of the Tennessee-Cumberland-Ohio River System 6
1.3 Historical Storms and Floods 10
2.0 EVENT SPECIFIC INFORMATION 11
2.1 Antecedent Conditions 11
2.2 Meteorological Summary 11
2.3 Hydrologic Summary 17
3.0 RESPONSIBILITIES OF FEDERAL AGENCIES DURING PERIODS OF FLOODING 21
3.1 Corps of Engineers 21
3.2 National Weather Service 23
3.3 United States Geological Survey 24
3.4 Tennessee Valley Authority 24
4.0 EMERGENCY OPERATIONS SUMMARY 26
4.1 LRN Timeline: Interaction between LRN and TEMA 27
4.2 LRL Timeline: LRL and Kentucky Lake/Lake Barkley 33
4.3 Additional Timelines 36
5.0 CORPS ACTIONS 37
5.1 Summary of Corps Water Management Operations 37
5.2 Summary of Corps Dam Safety Actions 53
5.3 Coordination with National Weather Service 55
5.4 Coordination with United States Geological Survey 56
5.5 Coordination with Tennessee Valley Authority 57
6.0 LESSONS LEARNED SUMMARY 58
6.1 Communication 58
6.1.1 External Communication 58
6.1.2 Internal Communication 59
6.2 Emergency Management 60
6.2.1 Emergency Operations Center 60
6.2.2 Logistics – Corps Logistics Activity (ULA) 60
6.3 Water Management 61
6.3.1 Infrastructure Maintenance 61
6.3.2 Hours of Operation 61
6.3.3 OHRFC/WFO Communication 62
6.3.4 Internet Outage 63
6.3.5 Quantitative Precipitation Forecasts (QPF) and Forecasts 63
6.3.6 Loss of Gage Data 64
6.3.7 Operation of the Cumberland River Basin System 64

DRAFT

Appendix A – Cost Information 66
Appendix B – PL84-99: Separate Projects and Major Activities 68
Appendix C – FEMA Mission Assignments 77
Appendix D – Corps Timeline of Events 78
Appendix E – National Weather Service Timeline of Events 94
Appendix F – Project and Gage Plots, and Tables 102
Appendix G – Photographs 240
Appendix H – Lessons Learned 246

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EXECUTIVE SUMMARY

The May 2010 Cumberland River Basin flood was an unprecedented event that greatly exceeded all forecasts. Flood damages from this event could not have been prevented. This After Action Report (AAR) examines the Corps operations and contains measures to better prepare for future flood events.

In May 2010 the Cumberland Basin experienced 36 hour rainfall event that produced record flooding. The historic rainfall and flooding across Tennessee and Kentucky was the result of a rare convergence of conditions that produced nearly stationary and intense storm activity on May 1 and 2 that created a large scale flash flood along the Cumberland and lower Tennessee Rivers and their tributaries. The two day storm was estimated to be far greater that a thousand year rain event.

> One of the primary missions of the U.S. Army Corps of Engineers is to support flood risk management activities of communities in both urban and rural areas throughout the United States. To carry out this mission, the Corps operates projects that reduce flood risk and conducts emergency management activities. The Corps' priority during flooding is to protect human life and property.

The Corps operated all flood risk management projects to reduce downstream flooding and initiated emergency management operations to provide assistance to state and local governments. The vast majority of the rainfall occurred in drainage areas uncontrolled by Corps flood risk management projects. During the event, the full storage capacity of Wolf Creek, Dale Hollow, and Center Hill dams was unable to be used because the rain fall was concentrated in drainage areas downstream of the projects. The J. Percy Priest dam, located just upstream of Nashville, was nearly overtopped during this event. Its flood storage capacity was exceeded requiring operation of the spillway gates to avoid overtopping. The navigation project, Cheatham Lock and Dam was overtopped. Spillway gate operations were required at the navigation projects of Cordell Hull and Old Hickory to prevent overtopping and losing control of water releases. At the height of the event, Corps personnel were making minute-by-minute decisions for the operation of eight projects in an extremely dynamic and dangerous environment. Preliminary analysis indicates that operations of the Corps projects reduced the Cumberland River flood crest in Nashville by approximately five feet.

The Corps values continuous improvement, transparency and accountability to the Nation. Following this event, the Corps committed to objectively and dispassionately review the facts of what happened during the event, transparently communicate the findings to the public, and then work to improve processes for the future. This After Action Report is the first step in fulfilling this commitment. It captures the lessons learned from this event and details areas that should be sustained and opportunities for improvement. The report was produced by completing a comprehensive, internal after action review process, during which the Corps consulted with partner agencies, including the National Weather Service, United States Geological Survey, Tennessee Emergency Management Agency, and the Tennessee Valley Authority.

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The report is organized into six chapters.

- Chapter 1, Background; provides a general description of the Tennessee-Cumberland-Ohio River system and the storms that occurred during this period.
- Chapter 2, Event Specific Information; covers the meteorological and hydrologic conditions before and during the event.
- Chapter 3, Responsibilities of Federal Agencies During Periods of Flooding; provides an overview of the roles and responsibilities of key federal agencies.
- Chapter 4, Emergency Operations Summary; provides timelines and a description of Corps emergency management operations in support of the Corps projects, state governments and local authorities.
- Chapter 5, Corps Actions; provides a detailed description of Corps water management and dam safety actions as well as coordination with other agencies.
- Chapter 6, Lessons Learned; provides a general overview of the issues identified during the after action review process.

Appendix H provides a detailed discussion of twenty-seven key issues organized in three topical areas: communications, emergency management, and water management. Other appendices provide additional relevant facts and data about the event.

The rapid onset and unprecedented magnitude of this event significantly challenged the Corps' projects, communications processes, and operations. The overall assessment is that the Corps operated its projects effectively and reduced the Cumberland River flood crest at Nashville by five feet. Corps projects were utilized to their fullest extent and in the most effective manner possible to minimize flooding. Pre-event water management actions, emergency management response, project operations, and coordination with the Tennessee Emergency Management Agency were areas the Corps will seek to sustain and capture as best practices. The report highlights the need for improvement in the areas of interagency communications, water management and emergency management. The report also reinforces the need for a more aggressive interagency effort to inform the public about the risks of flooding, capabilities and limitations of Corps projects, and how to access flooding information, warnings, and predictions. The Corps will rapidly address issues requiring improvement and institutionalize practices that worked well in order to be better prepared for future events.

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1.0 BACKGROUND

1.1 Purpose

On May 1-2, 2010, a historic rainfall event brought large-scale, regional flash flooding to western Tennessee and Kentucky. The flooding primarily affected the lower Tennessee-Cumberland-Ohio River system. Despite the existence of United States Army Corps of Engineers (Corps), Tennessee Valley Authority (TVA) and private flood protection projects, damages from the flooding are estimated to be in excess of 2 billion dollars. This After Action Report (AAR) is a summary of the operations and the interagency coordination that occurred during this unprecedented event. The review of this event allows the Corps, along with its partner agencies, to evaluate opportunities for improvement (Lessons Learned) by addressing the following questions:

What happened?

Why did it happen?

What was supposed to happen?

How will we improve?

The report first reviews the characteristics of the flood risk management system and its hydrologic response to the current and past rainfall events. The AAR next provides a description of the Corps' Emergency Management and Water Management teams' actions followed by Lessons Learned.

1.2 Description of the Tennessee-Cumberland-Ohio River System

Figure 1 illustrates the Ohio River watershed. The Ohio River originates at the confluence of the Allegheny and Monongahela Rivers in Pittsburgh, Pennsylvania. The Ohio River then flows along the borders of Ohio, West Virginia, Kentucky, Indiana and Illinois to its confluence with the Mississippi River at Cairo, Illinois. The Ohio River is 981 miles long and has a total drainage area of 204,430 square miles covering parts of 15 states. The Ohio River is the largest tributary, by volume, to the Mississippi River and contributes, on average, 60 percent of the flow to the Mississippi River. Upstream of its junction with the Mississippi, 46 miles and 58 miles, respectively, the Tennessee and Cumberland Rivers enter the Ohio River. These major tributaries have watersheds that comprise nearly 30% of the Ohio River Watershed: 20% for the Tennessee River and 9% for the Cumberland River – nearly 30% in total - of the Ohio River watershed.

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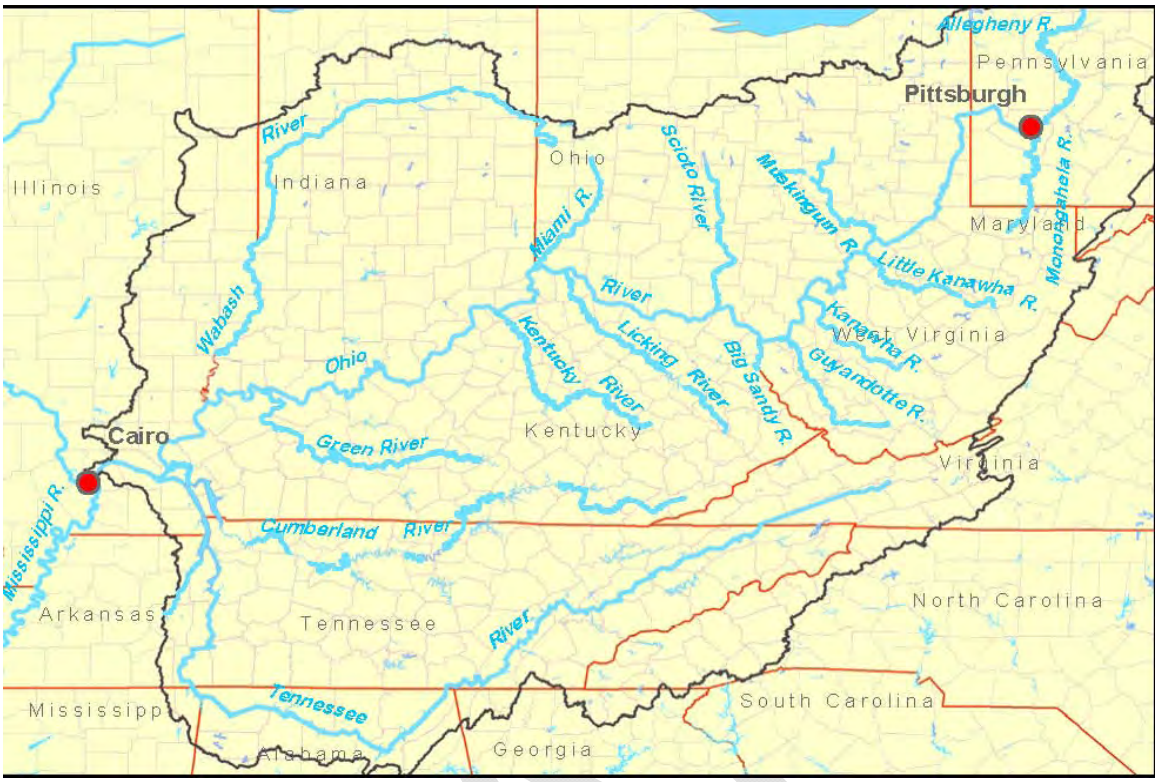

Figure 1 – Ohio River Basin.

The Cumberland River, second largest tributary of the Ohio River, originates at the junction of Poor and Clover Forks near the City of Harlan in southeastern Kentucky. From that point the 694 mile long river flows generally southwesterly to Nashville, Tennessee; there it turns northwesterly and flows into Western Kentucky. It enters the Ohio River at Smithland, Kentucky, 58.5 miles up-stream from the confluence of the Ohio and Mississippi Rivers near Cairo, Illinois, and 922 miles downstream from Pittsburgh, Pennsylvania. The somewhat crescent shaped Cumberland River Basin lies entirely within the States of Kentucky and Tennessee and has a total area of 17,914 square miles, of which 10,695 square miles (60 %) are in Tennessee. The topography of the basin varies from rugged mountains in the eastern up-stream portion to rolling low-plateaus in the western, or downstream, sector. Elevations range from 4,150 feet above mean sea level (msl) in the Cumberland Mountains to 302 feet in the pool at the mouth of the river.

The Corps of Engineers, Nashville District, is responsible for the operation and maintenance of five projects on the mainstem of the Cumberland River and five projects on tributaries to the river. The mainstem projects are Barkley, Cheatham, Old Hickory, Cordell Hull and Wolf Creek (Lake Cumberland). Of these 5 mainstem projects, only Barkley and Wolf Creek are congressionally authorized for flood damage reduction (meaning they are specifically intended to store water to assist in minimizing flood damage). Barkley, Cheatham, Old Hickory and Cordell Hull are congressionally authorized for commercial navigation and hydropower. Wolf Creek is also congressionally authorized for hydropower. Barkley plays a unique role in lower Ohio-Mississippi River flood control, in tandem with Kentucky Lake on the Tennessee River. These two lakes are connected by a 1.5 mile canal and must be operated in tandem. The tributary projects, Dale Hollow, Center Hill, J. Percy Priest, Martins Fork and Laurel are also

congressionally authorized for flood damage reduction. With the exception of Martin's Fork, these projects are also congressionally authorized for hydropower. Table 1 summarizes the congressionally authorized project purposes. Martins Fork and Laurel are small relative to the other tributary projects and only provide flood protection benefits locally. Figure 2 is a general map of the Cumberland Basin and surrounding area. Figure 3 illustrates the existing projects.

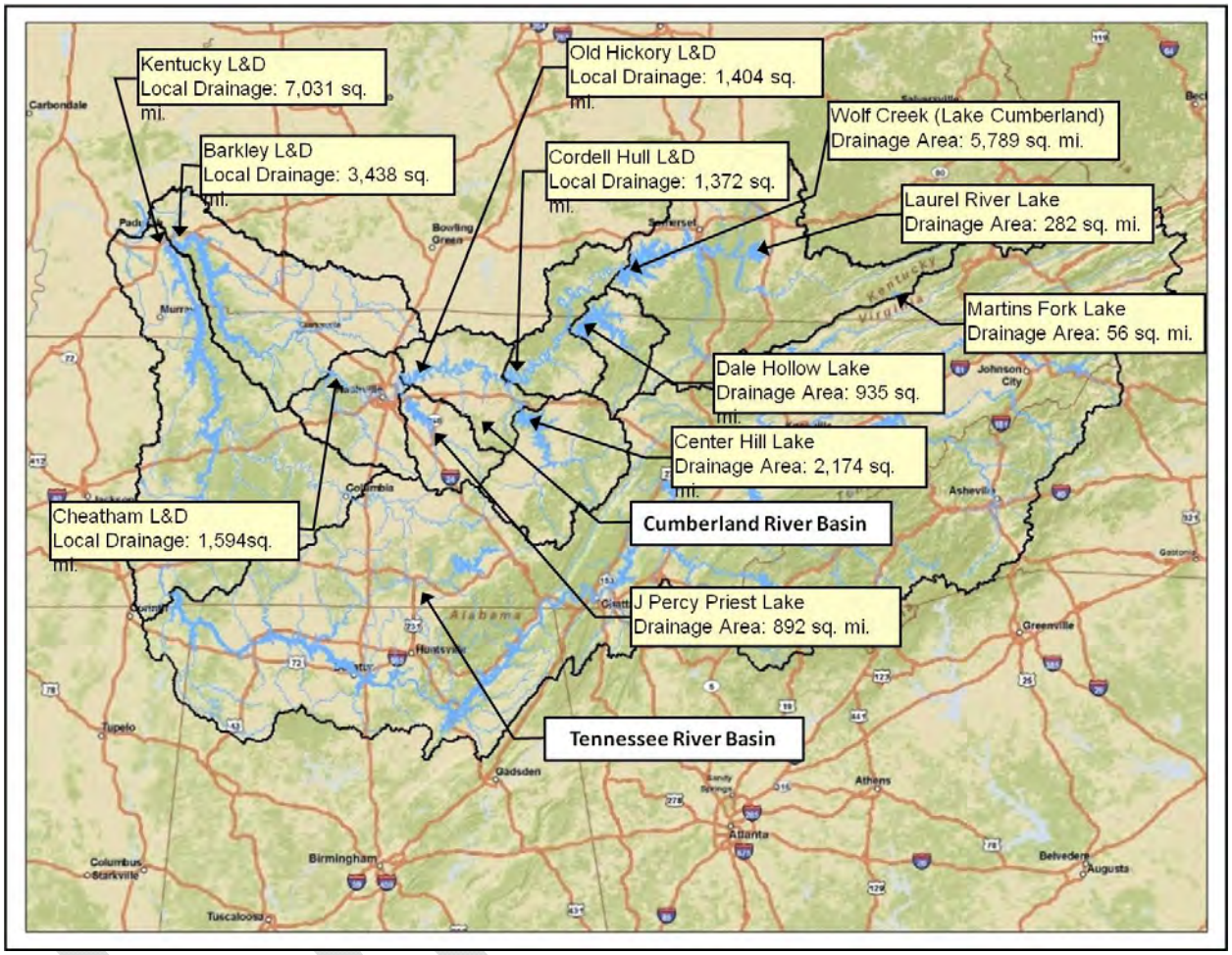

Figure 2 – Cumberland River Basin.

The TVA is responsible for the operation of the projects on the Tennessee River. However, under Section 7 of the 1944 Flood Control Act, and by letter dated 30 April 1947 to the Chairman, Tennessee Valley Authority, the Secretary of War formally designated the Division, Engineer, Ohio River Division as the representative responsible for issuing instructions to the TVA for regulation of releases from the Tennessee River when danger from floods exist on the lower Ohio and Mississippi Rivers. The flood control operation of these two reservoirs is unique. The Corps operates these projects with the primary purpose of protection and preservation of the Mississippi River levee system. Operational guidelines prohibit the commitment of 100% of their flood control storage to a single storm event, in order to preserve storage for any follow-on events that may threaten the Mississippi River levee system. There are no maximum outflow constraints on these two reservoirs.

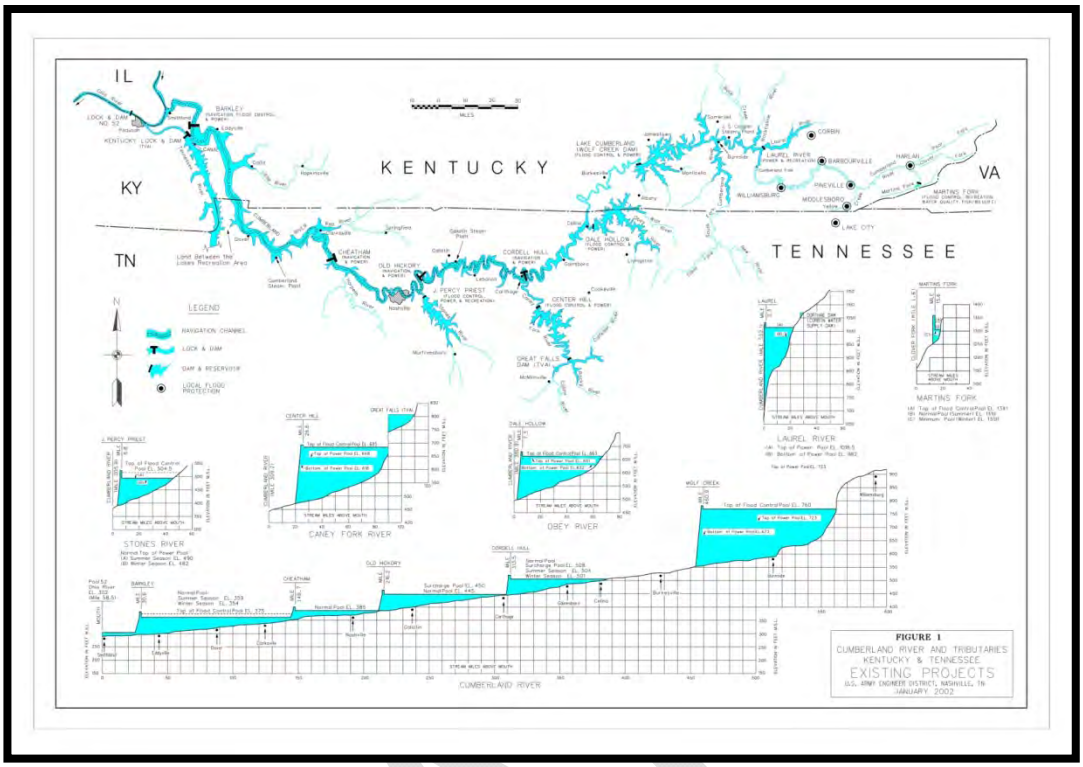

Figure 3 – Corps Projects in the Cumberland River Basin.

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Table 1 – Congressionally Authorized Project Purposes.

Project	Flood Damage Reduction	Commercial Navigation	Hydropower	Recreation	Water Quality	Fish & Wildlife
Mainstem Projects						
Wolf Creek Dam	X		X		X	X
Cordell Hull Lock & Dam		X	X	X	X	X
Old Hickory Lock & Dam		X	X		X	X
Cheatham Lock & Dam		X	X		X	X
Barkley Lock & Dam	X	X	X		X	X
Tributary Projects						
Martins Fork Dam	X			X	X	X
Laurel Dam			X	X	X	X
Dale Hollow Dam	X		X		X	X
Center Hill Dam	X		X		X	X
J. Percy Priest Dam	X		X	X	X	X

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1.3 Historical Storms and Floods

The track and direction of large flood-producing storms in the Cumberland watershed generally parallel the southwest to northeast orientation of a major part of the basin. Almost all floods on the mainstem of the Cumberland River occur in the period from late November to mid-May, mainly because precipitation amounts are greatest during that time of year and hydrologic conditions are conducive to excessive runoff. In almost all historical events, some parts of the basin receive relatively small amounts of rainfall while other portions experience extreme rainfall. For example, three outstanding historic floods that produced maximum flood heights on much of the Cumberland River were those of December 1926 – January 1927, January 1937, and March 1975. The December 1926 – January 1927 flood was produced by an 8-day storm with three separate rainfall bursts that concentrated heavily above areas now controlled by storage reservoirs, but at that time combined to produce maximum crests along a reach extending from above Carthage to below Nashville. Long duration rainfall produced the January 1937 flood, but unlike that of 1926-1927, the greatest intensities and the heaviest accumulations of rainfall were downstream from Nashville. This storm produced all-time record stages on the lower 150 miles of the Cumberland River. Contrasted with these historic storms and floods, the March 1975 storm was of a relatively short duration (four days), very intense and widespread, and was located so as to produce extreme flooding in nearly all portions of the basin.

Prior to the May 2010 event, the last time the Cumberland River reached flood stage at Nashville was in May 1984. The May 1984 event experienced a series of rains spread over an extended period of time resulting in a major basin-wide event. The flood crest at Nashville for this event was a stage of 45.26 feet. Since 1984 there have been several flood events that came within a couple feet of reaching the flood stage at Nashville. These events include significant March events in 1989 (peak stage 39.53), 1994 (peak stage 38.05), and 1997 (peak stage 39.36). There was also a high flow event in May 2003 when the stage at Nashville reached 38.05 feet. A series of significant rainfall periods coming in succession over a several week period characterized these events. Any of these storms, taken individually, did not pose a significant threat to the system; however, collectively, they resulted in significant flood events. Multiple follow-on events of this nature are often responsible for producing flood events along the Cumberland River. The May 2010 storm was unique, acting more like a flash flood event. It was very intense, widespread, and produced record rainfall, stage, and discharge for several projects across the basin. Some areas received rainfall amounts that exceeded 17 inches during the two day event, the highest amount in more than 140 years of record. Much of the rain fell in areas not controlled by the Corps reservoirs. Two of the hardest hit sub-basins, the Harpeth River and Mill Creek, both enter the Cumberland River within the Cheatham pool and were major contributors to record river levels during this event. Nashville also lies within the Cheatham pool. With so much rainfall occurring over the uncontrolled portion of the basin, the flood damage reduction projects were not in a position to play a major role of reducing flood crests along the Cumberland.

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2.0 EVENT SPECIFIC INFORMATION

2.1 Antecedent Conditions

Major large-scale flood events are typically the culmination of an extended wet period which increases soil moisture and streamflows, increasing the potential for runoff. However, the May 2010 historic flooding in Tennessee and Kentucky was not preceded by a wet period; in fact, conditions ranged from near normal to drier than normal across the region.

During the three months prior to the flood (February through April), a strong El Nino was present in the equatorial Pacific Ocean. This shifted the average storm track across the United States southward, with most storms moving eastward along the Gulf Coast before turning northeast along the eastern seaboard. This resulted in the record-setting snowfall season along the east coast, but the bypassed Tennessee and Cumberland valleys were drier than normal, with central Tennessee and Kentucky recording only 40 to 80 percent of normal precipitation during this time. By the end of April, areas in central Tennessee and the eastern two-thirds of Kentucky were designated as "Abnormally Dry" by the United States Drought Monitor. Areas in central Kentucky near Lexington were the driest within the regions during the spring (Lexington only recorded 1.13 inches during the month of March), and were classified by the Drought Monitor as experiencing "Moderate Drought".

In response to the below normal rainfall, streamflows were below normal across Tennessee and Kentucky for much of the spring. However, showers and thunderstorms moving through the region on April 24th brought widespread rainfall of 1 to 3 inches to the area. Runoff from these storms did not produce flooding, but did increase streamflows to normal levels immediately prior to the flood event.

2.2 Meteorological Summary

The May historic rainfall and incredible flooding across Tennessee and Kentucky was the result of a relatively rare convergence of conditions favorable for a prolonged and intense rainfall event over the central United States. Four primary factors contributed to the rainfall – an unseasonably strong late-spring storm system, a stationary upper air pattern, a persistent tropical moisture feed, and the timing of impulses moving through the jet stream.

On Tuesday, April 27, a powerful storm system moved ashore in the Pacific Northwest, maintaining its strength as it crossed the Rocky Mountains on Wednesday and Thursday and moved into the central portion of the United States on Friday, April 30. The system was unseasonably deep - maintaining a central pressure of at least 988 millibars (mb) as it tracked eastward - and geographically large for late April, simultaneously influencing weather from the Sierra to the Ohio Valley on Friday. The primary low pressure center associated with the system was located in the northern plains, with a cold front trailing southward from the low all the way to the Rio Grande (Figure 4).

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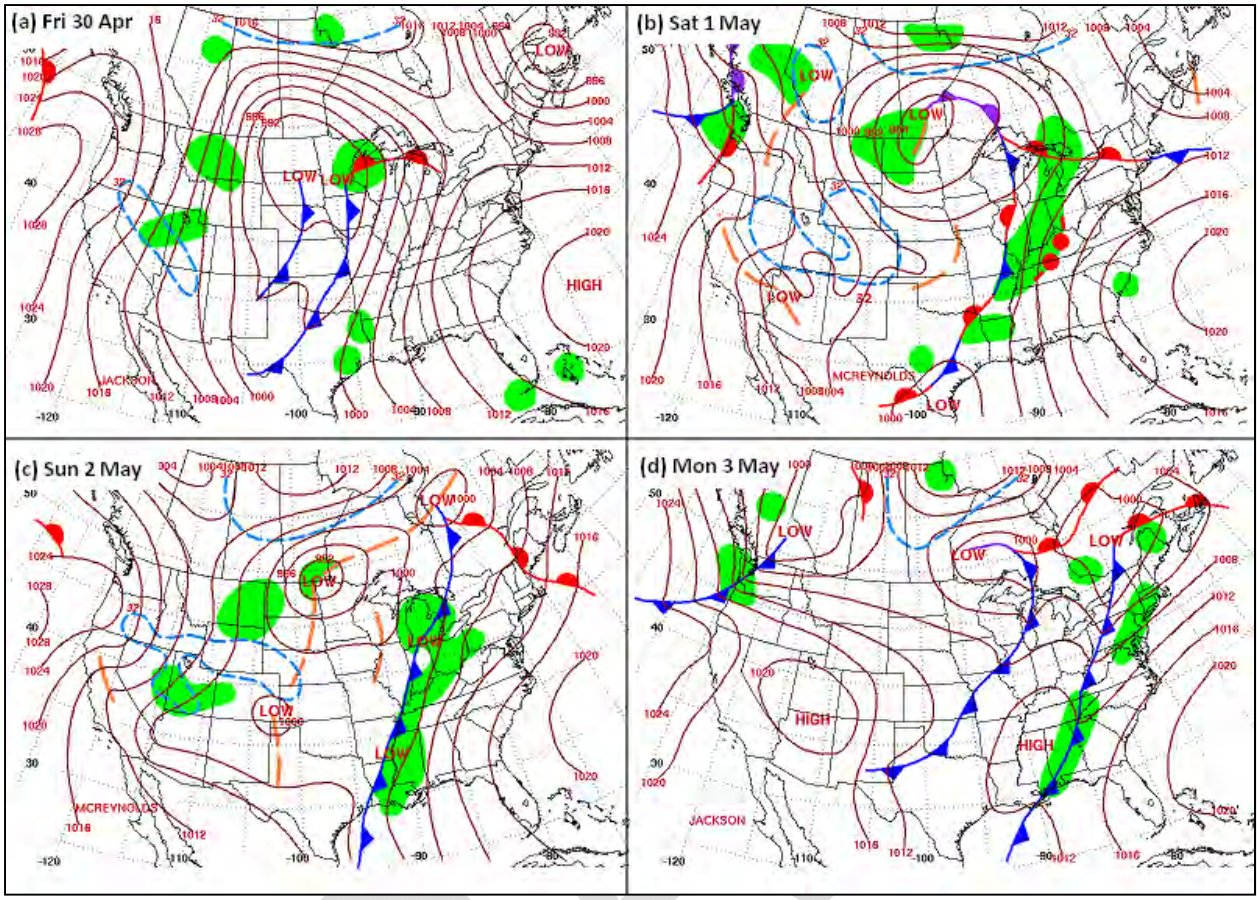

Figure 4 – Hydrometeorological Prediction Center 7 AM CDT (12 UTC) Surface Map Analysis for Friday April 30 – Monday May 3, 2010. The low pressure area moving into the central plains intensified on Friday, April 30 (panel (a)), resulting in a strong northerly flow out of the Gulf of Mexico into the Mississippi and Tennessee/Cumberland River Valleys. The frontal boundary moving through the central plains on the 30th stalled along the Mississippi River Saturday through Sunday night, providing a stationary focus for thunderstorm redevelopment over the same regions.

Wrapping around the system was an extremely dynamic jet stream (Figure 5), which swung from the Gulf of Alaska southward into central Mexico, then northward through the Mississippi Valley and into Eastern Canada. This configuration resulted in an extremely favorable upper-air environment for widespread severe thunderstorms and heavy rainfall over the mid-Mississippi, Tennessee, and Cumberland River Valleys.

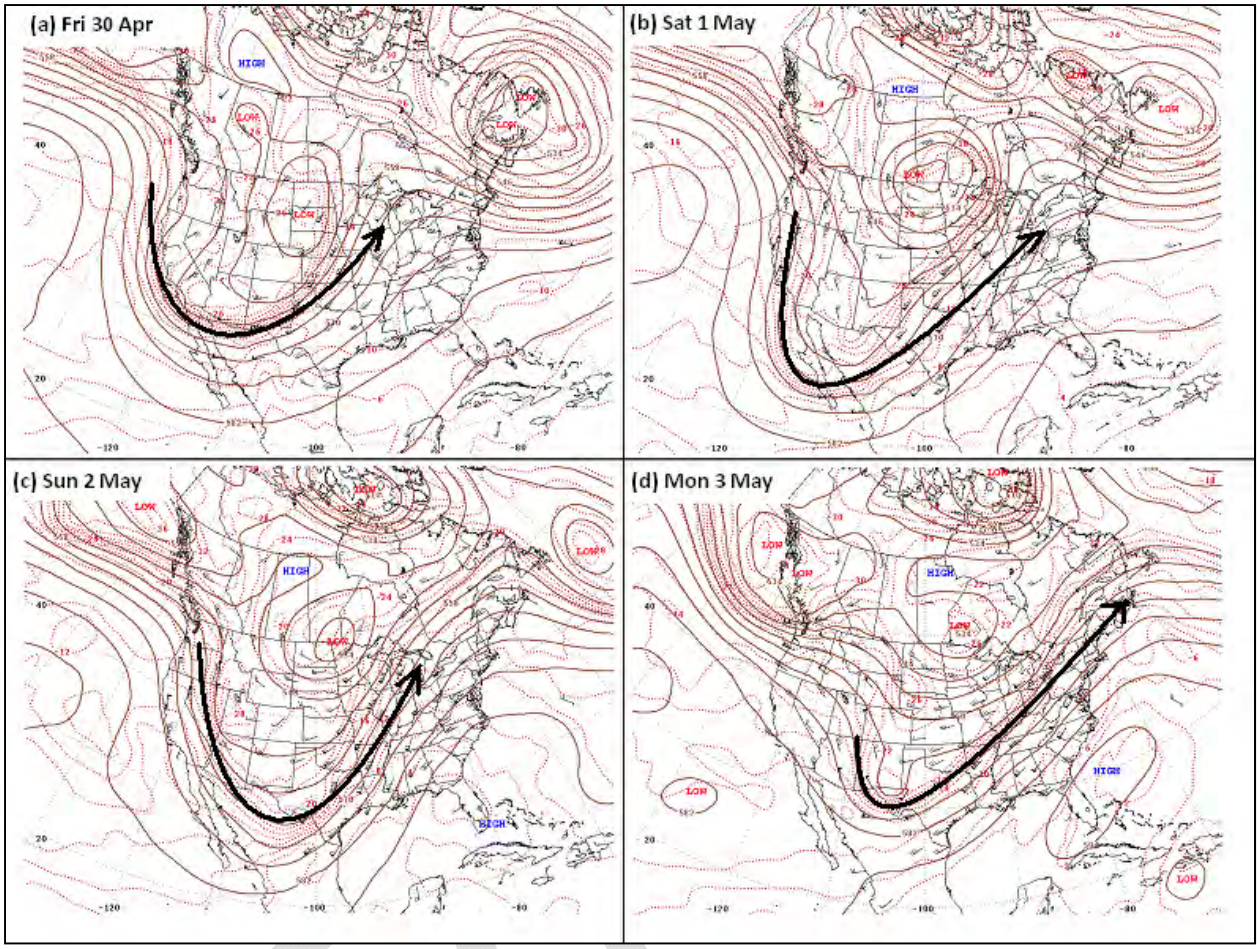

Figure 5 – Hydrometeorological Prediction Center 7 AM CDT (12 UTC) 500 hPa Analysis for Friday April 30 to Monday May 3, 2010. Location of the primary jet stream is delineated by a heavy black arrow. The most favorable area for thunderstorm activity tends to be near the end of the arrow head, on the northbound limb of the jet stream. Thunderstorm activity was enhanced when this area moved very little from Saturday through Sunday. The orientation of the jet stream parallel to the surface front prevented the front from progressing eastward.

This pattern would change little from Friday night through Monday morning as a blocking pattern[1] over eastern North America and the northern Atlantic Ocean strengthened. This prevented the storm system and upper air pattern from moving eastward. The strong counterclockwise flow around the low tapped into moisture from the equatorial Pacific Ocean, drawing a river of tropical air northward across the Gulf of Mexico and into the Mississippi Valley. This provided an inexhaustible supply of moisture to fuel thunderstorms forming along the stalled front. (Figure 6)

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[1] **Atmospheric blocking occurs when the typical west-to-east migration of storms in the mid-latitudes becomes stationary, keeping upper air flow patterns locked in place for an extended period of time. During the May flood event, the blocking pattern resulted in a strong jet stream oriented from Mexico to eastern Canada which moved little over a three day period, drawing extensive amounts of tropical moisture northward. (Figure 6)**

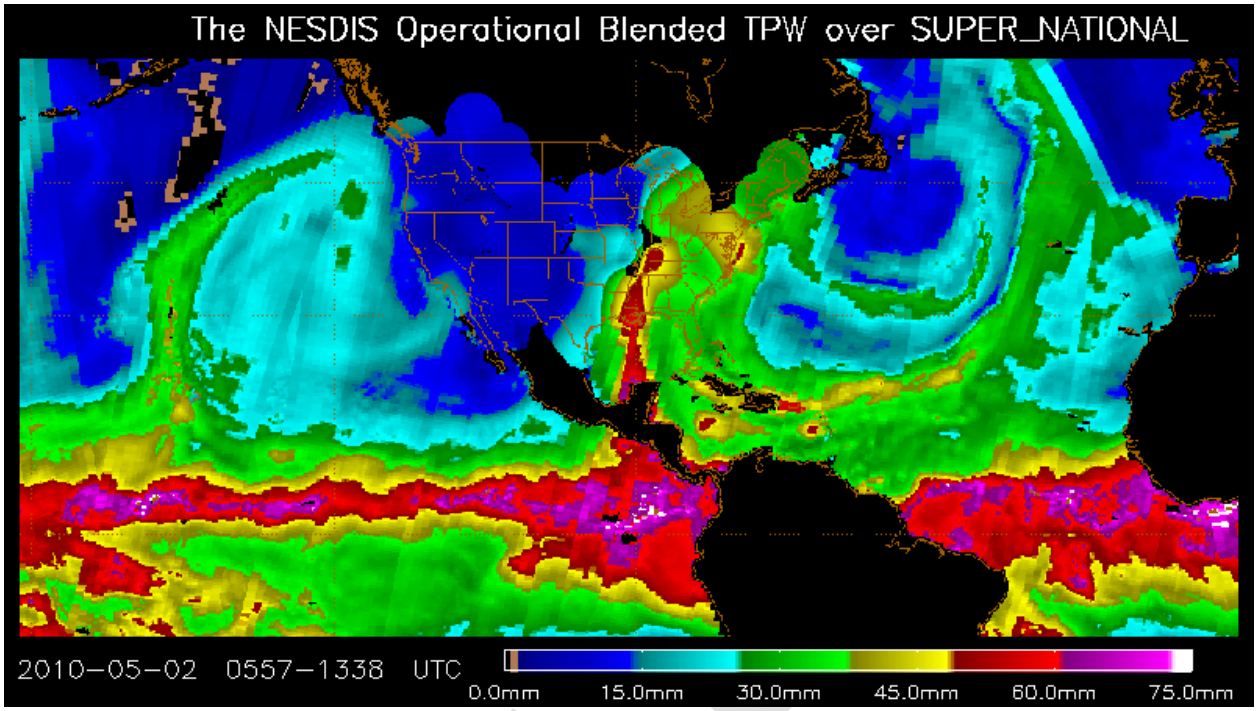

Figure 6 – Satellite estimated precipitable water plot from 1338Z (8:38 am CDT) May 2 2010. Values of red and purple show areas of extremely high concentrations of water vapor through the entire depth of the atmosphere. The source region of the tropical moisture that resulted in the incredible rainfall totals in Tennessee and Kentucky was the Inter-tropical Convergence Zone (ITCZ) along the equator. The long duration of the stalled upper air pattern allowed enough time for the intact plume of equatorial moisture to be transported northward into the central United States.

Waves of thunderstorm activity typically require a disturbance[2] moving through the jet stream to provide enough energy to begin convection. A shortwave triggered the first burst of thunderstorm activity on Saturday as it moved into the lower Mississippi Valley at the time of peak afternoon heating. Thunderstorm activity focused initially along the stalled frontal boundary, moving northeast in the upper level flow. In addition to a significant tornado outbreak in the mid-south, the steady stream of tropical moisture caused additional thunderstorms to form on the rear flank of existing storms – a classic "backbuilding" scenario. The net result was a nearly stationary area of thunderstorms, which produced 5 to 8 inches of rainfall across central and eastern Tennessee by Sunday morning.

A second shortwave approached the region on Sunday, initiating a second round of intense thunderstorm activity. Since the frontal boundary and upper air pattern had not changed significantly, thunderstorms again focused across the Tennessee and Cumberland Valleys. Typically large thunderstorm complexes, such as the one which occurred on Saturday evening, will temporarily deplete the local moisture supply in the atmosphere, limiting chances for a second round of thunderstorms in the same location within 24 hours. However, the tropical moisture feed noted above allowed the atmosphere to recover quickly, providing ample recharge of the moisture needed for heavy rainfall to occur on Sunday through Monday morning.

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[2] **These disturbances are typically referred to as "shortwaves". Shortwaves are small circulations moving rapidly through the upper air flow. Shortwaves play an important role in thunderstorm development, causing air to rise as they approach. This aids initiation and maintenance of thunderstorm activity.**

The back-to-back nature of the thunderstorm activity resulted in historic rainfall totals across Tennessee and Kentucky where intense rains fell on both days. The heaviest rains fell in a swath stretching from Memphis to Nashville in western and central Tennessee, where rainfall in excess of 15 inches was measured (Figure 7). Nashville received 13.57 inches of rainfall over the two day period, more than doubling the previous two day rainfall record of 6.68 inches set in September 1979, and even exceeding the previous *monthly* May record of 11.04 inches. An observer northeast of Camden, TN near Kentucky Lake recorded 19.41 inches during the event. The highest measured rainfall totals reported by the National Weather Service from volunteer observers in Tennessee and Kentucky are included in Table 2.

The National Weather Service Hydrometeorological Design Studies Center computes the average recurrence interval of rainfall events, shown for this flood in Figure 8. In the hardest hit locations in Tennessee, the 48 hour rainfall totals measured during this event would be greater than a 1000 year event, which means it has a less than 0.1 percent chance of occurrence in any one year.

Table 2 – Highest measured rainfall totals in Tennessee reported during the May 1-2 Flood Event by National Weather Service Cooperative Observers and members of the Community Collaborative Rain, Hail, and Snow (CoCoRaHS) network.

Location	Total Two Day Rainfall
Camden 4.5 NE	19.41"
Fairview 3.8 SW	18.04"
Fairview 2.9 SW	17.71"
Belle Meade 1.4 NNE	17.67"
Mt Moriah Birdsong Marina	17.51"
Brownsville 1.0 SE	17.50"
Jackson 4.9 NW	17.36"
Brentwood 2.5 NE	17.15"
Bon Aqua 3.0 ESE	17.09"
Brentwood 2.8 NE	17.07"
Belle Meade 1.2 ESE	17.02"

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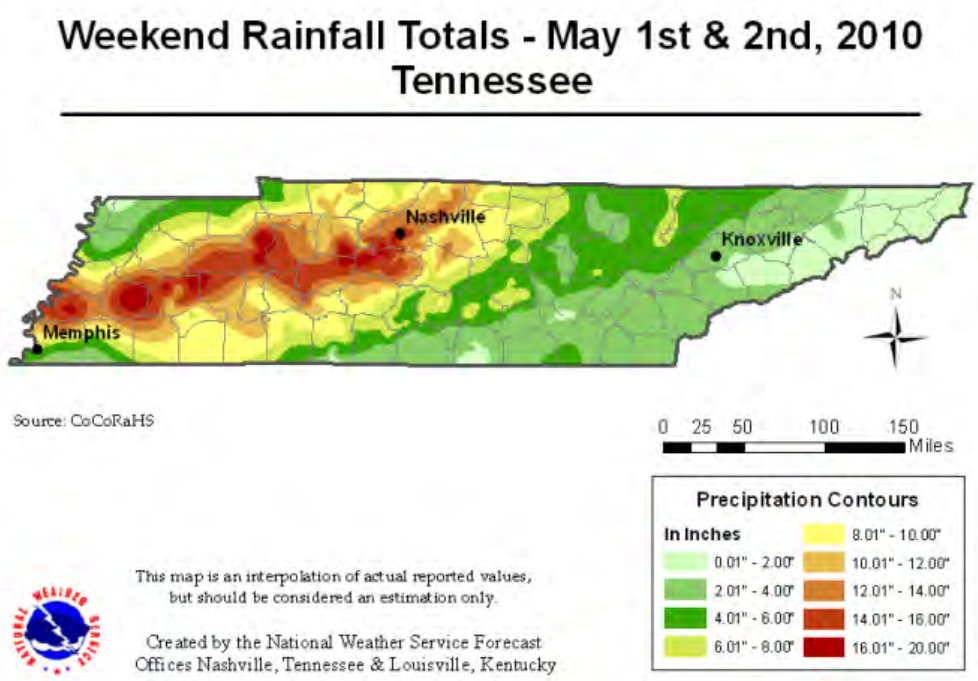

Figure 7 - Interpolated Rainfall total map from the May 1-2 Flood Event. Graphic produced by the National Weather Service Forecast Offices in Nashville, Tennessee and Louisville, Kentucky.

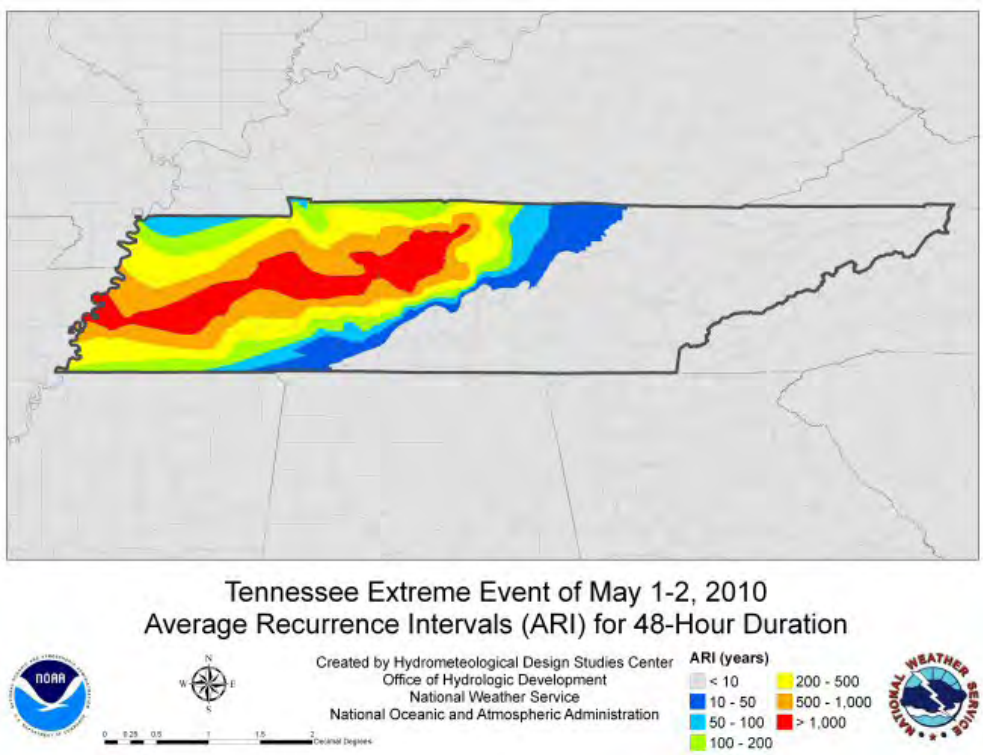

Figure 8 - Average Recurrence Interval (ARI) for the May 1-2 Rainfall Event. Areas in red indicate areas where rainfall totals for this event exceeded a 1 in 1000 probability of happening in a given year. Graphic courtesy of the Hydrometeorological Design Studies Center of the National Weather Service.

2.3 Hydrologic Summary

The runoff response from the first round of thunderstorms on Saturday, May 1, produced sharp rises on nearly all streams and rivers across western and central Tennessee. The second round of thunderstorm activity on May 2 created a second rise on smaller creeks in the area which had already crested, but resulted in a renewed acceleration in water levels along larger creeks and streams, many of which had been nearing crest. The additional round of very heavy rainfall on May 2, falling on already saturated ground and flowing into river systems already at flood stage, significantly increased the flood wave building on the mainstem Cumberland River.

Entire river basins averaged over 6 to 10 inches of rainfall in the hardest hit areas, effectively causing a large-scale flash flood along the Cumberland and lower Tennessee Rivers and their tributaries. Record stages occurred at many locations in central Tennessee, including points along the Stones, Harpeth, Red, and mainstem Cumberland Rivers in the Cumberland Basin and the Duck and Buffalo Rivers in the Kentucky Lake watershed. Stream gaging equipment at four locations (the Harpeth River at Bellevue, Harpeth River at Kingston Springs, Bledsoe Creek at Rogana, and the Duck River at Hurricane Mills) was damaged by the high water. High water surveys continue as of the time of this report to determine the actual crest levels at these locations.

The area of heaviest rain fell in uncontrolled drainage areas[3] which flow directly into the mainstem Cumberland and Tennessee Rivers. In the Stones River basin, J. Percy Priest Dam utilized 100 percent of its available flood storage capacity in an effort to reduce crest levels downstream. However, water from the Harpeth River, Red River, and numerous other small tributaries to the Cumberland flowed unchecked into the mainstem, producing the historic crests observed at Nashville, Clarksville and Cheatham Lock and Dam (Figure 9).

Water level and discharge records were set on numerous tributaries and at several mainstem locations across the Cumberland and Tennessee River Basins during the event. Table 3 summarizes the significant river crests in central Tennessee associated with the flood event. Table 4 contains peak pool elevations and discharges at Corps Flood Control Reservoirs and navigation dams in the Cumberland River basin during the height of the event. Appendix F provides a comprehensive summary of hydrographs for all gaging locations and Corps projects in the Cumberland Basin.

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[3] **The uncontrolled drainage area is that portion of the watershed that is not upstream of a flood control dam.**

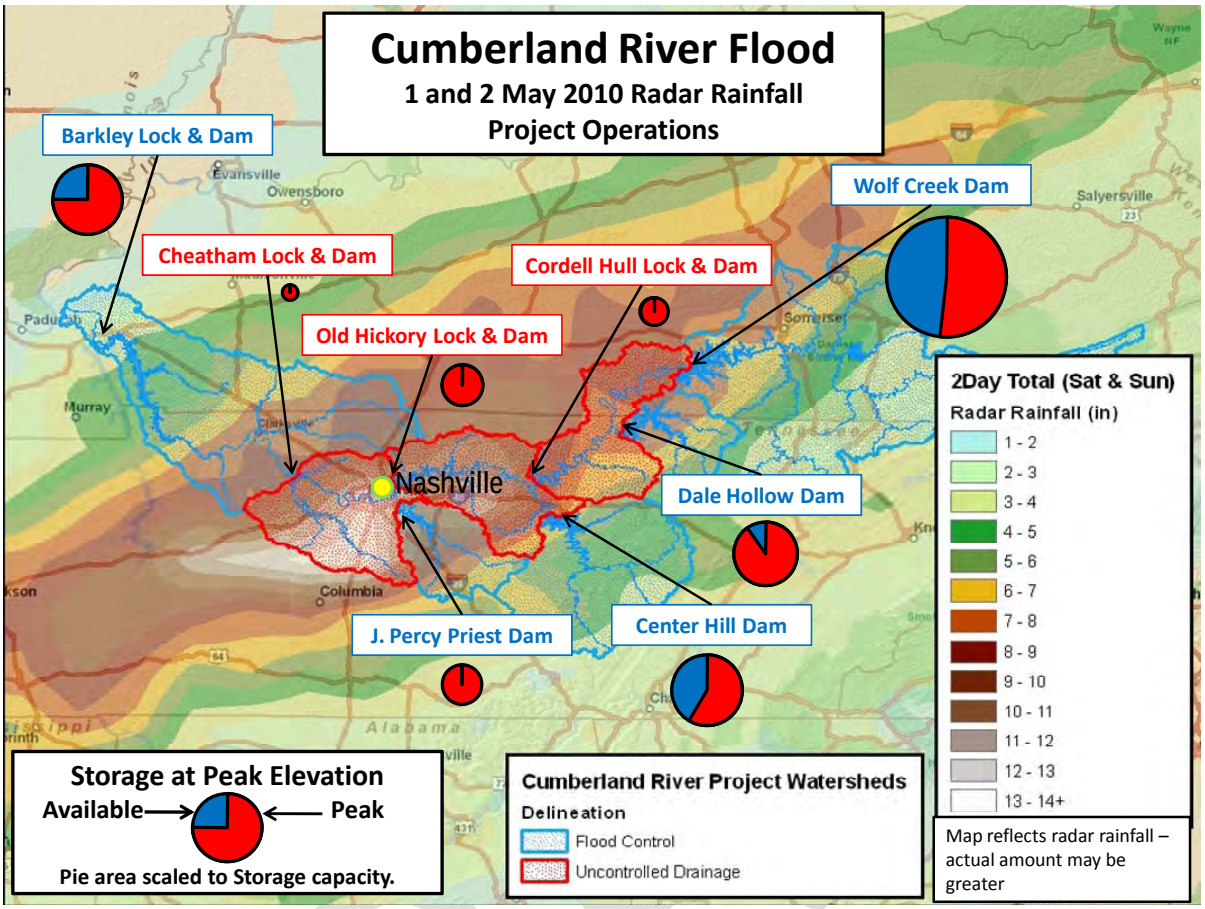

Figure 9 - Overlay of precipitation data with drainage areas in the Cumberland River Basin. Areas outlined in red indicate uncontrolled drainage areas; areas highlighted in blue indicate drainage areas which flow directly into a Corps Flood Control Project. Pie charts show the relative capacity for each project as well as how much capacity was utilized during this event. The heaviest rain was observed in the unregulated tributaries downstream of the four flood control projects in the basin, resulting in the historic rises at Nashville and Clarksville.

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Table 3 - Record or Near-Record Flood Levels set during the May 1-2 flood event.

Location	Flood Crest[5]	Old Record	Date of Old Record	Flood Stage[4]	Estimated Flow Frequency[3]
Cumberland River at Clarksville	62.58'	57.1'	March 14, 1975	46'	270 yr
Cumberland River at Nashville	51.86' [1]	47.6'	March 15, 1975	40'	300 yr
Red River near Port Royal	49.48'	48.3'	March 13, 1973	30'	115 yr
Duck River at Centerville	47.50'	37.6'	February 14, 1948	22'	>500 yr
Duck River near Hurricane Mills	33' [2]	30.7'	February 14, 1948	24'	440 yr
Harpeth River near Kingston Springs	38' [2]	33.2'	January 7, 1946	20'	>500 yr
Harpeth River at Bellevue	33' [2]	24.3'	February 13, 1948	20'	>500 yr
Harpeth River at Franklin	35.18	35.2	February 13, 1968	30'	70 yr
Buffalo River near Lobelville	25.7'	25.2'	May 28, 1991	14'	200 yr

[1] **Record based on post-regulation era; Flood crests prior to the construction of flood control projects were higher in Nashville**

[2] **Last observed reading from these locations before gaging equipment failed. Final crest stages will likely be several feet higher at these sites.**

[3] **Flood frequency estimates are based on a preliminary analysis. The final figures may vary somewhat from these estimates.**

[4] **Data from the National Weather Service Forecast office in Nashville, TN.**

[5] **Crest data is preliminary and subject to change following field surveys.**

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Table 4 - Peak Pools and Discharges at Nashville District Projects during the May 2010 Flood. Previous record pools and discharges are noted for reference.

Project	Maximum Pool During May 2010 Event	Pool of Record	Date of Record Pool	Maximum Discharge During May 2010 Event	Record Discharge	Date of Record Discharge
Mainstem Projects						
Wolf Creek Dam	703.86	751.70	5/13/1984	14,880	40,360	12/29/1951
Cordell Hull Lock and Dam	508.33	508.33	5/3/2010	130,100	130,100	5/3/2010
Old Hickory Lock and Dam	451.45	451.45	5/2/2010	212,260	212,260	5/2/2010
Cheatham Lock and Dam	404.15	404.15	5/3/2010	240,000	240,000	5/3/2010
Barkley Lock and Dam	369.00	370.04	5/13/1984	303,200	303,200	5/4/2010
Tributary Projects						
Martins Fork Dam	1322.18	1331.63	4/20/1998	515	1,263	4/20/1998
Laurel River Dam	1016.07	1022.47	3/13/1975	3,710	14,030	3/13/1975
Dale Hollow	657.34	660.98	3/15/1975	2,005 *	13,970	2/17/1950
Center Hill	646.76	681.52	5/10/1984	3,750 *	40,500	2/12/1950
J Percy Priest	504.90	505.18	5/9/1984	8,600 *	20,740	6/22/1970

*** Discharges shown are the maximum releases from each project during the mainstem Cumberland River crest.**

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3.0 RESPONSIBILITIES OF FEDERAL AGENCIES DURING PERIODS OF FLOODING

3.1 Corps of Engineers

During periods of flooding, one of the primary missions of the Corps is to support flood risk management activities of communities in both urban and rural areas throughout the United States. To carry out this mission, the Corps operates projects that reduce flood risk and conducts emergency management activities. The Corps' priority during flooding is to protect human life and property. We perform this mission as part of an interagency team with our Federal, State, and municipal agency partners.

The Corps is responsible for regulating its projects in accordance with the provisions of the authorizing legislation and the water management criteria defined in reports prepared by the Corps during the planning and design phases of a project or system. Additional water management criteria may also be required by provisions established by applicable authorities and congressional acts related to the operations of federal facilities. Each project has a water control plan that provides the criteria for the operation of the project. As conditions warrant, Water Management (WM) updates water control plans to account for changing needs.

The water control plans provide instructions on how best to utilize the flood storage at the project to assist in minimizing the flooding downstream along the projects' mainstem and tributaries. Water Management operates the projects by evaluating the entire watershed system, taking into consideration uncontrolled tributary drainage areas downstream, reservoir storage capacity, and the volume and time distribution of inflows from upstream drainage areas into the project. Since each flood has its own unique hydrometeorological conditions, WM regulates the projects based on a constant, on-going analysis of observed and forecast conditions during that particular event. Models using runoff for the event and regulation criteria provide analytical data which facilitate analysis. The Corps and USGS gages provide stream gage and precipitation data which contribute to these models.

The Nashville District (LRN[4]) is responsible for regulation of the reservoirs in the Cumberland River Basin. These reservoirs also contain hydropower facilities. The power generation at the projects is governed by a formal operating agreement between the Corps, the (TVA), and Southeastern Power Administration (SEPA). On a daily basis, LRN WM determines the daily total hydropower output for each plant, and TVA develops the hourly schedule. LRN performs continuous review of the hydropower operations to ensure they are in accordance with the authorized project purposes. When flood control operations are required for the Cumberland Basin projects, all other operating objectives (including hydropower) become secondary considerations. To the extent practical, however, hydropower production is maintained at the

[4] **The Nashville District is also referred to as LRN, short for "Lakes and River Nashville" in recognition of its being part of the Great Lakes and Ohio River Division of the Corps.**

projects during flood control operations, but only to the degree that supports lake level and project discharge operating objectives.

The Great Lakes and Ohio River Division (LRD) WM is responsible for monitoring the regulation of the Districts reservoirs. Additionally, LRD WM is responsible for directing the flood control operations of Barkley and Kentucky reservoirs, which requires coordination with other agencies and the Mississippi Valley Division (MVD). During flood events, each District in the Ohio River Valley provides LRD WM its predictions of reservoir releases and elevations and tributary flow at the lower most gage location to the Ohio River. LRD WM uses this information to assist in its analysis of the Ohio River and to coordinate the flows from the Ohio River with MVD.

The Corps provides support to the state Emergency Management Agencies as authorized by Public Law 84-99. Public Law 93-288, the Robert T. Stafford Relief and Emergency Assistance Act, authorizes the Corps to support Federal Emergency Management Agency (FEMA) as the lead agency in Emergency Support Function (ESF) #3[5]. In accordance with Engineer Regulation (ER) 500-1-1 and Engineer Pamphlet (EP) 500-1-1 and LRD formulated emergency plans, each District has assigned state response duties. In the Cumberland Basin area, Nashville District has the responsibility for providing assistance to Tennessee, while Louisville District (LRL) is responsible to Kentucky. Upon activation of the state Emergency Operations Center (EOC), the responsible Corps District, in coordination with the state, deploys an Emergency Management (EM) Liaison to the state EOC. Both Tennessee and Kentucky requested, and LRN and LRL provided, an LNO to each of their respective states during the May 2010 Flood. There are often several Districts affiliated with a state, but only one District has responsibility as the "lead" District in event of emergencies.

Duties also include providing technical and material assistance for flood fighting. Technical assistance, in this instance, included sand-bagging operations and their proper placement; placement and operations of water pumps; and inundation maps. Material assistance included sandbags, rolls of plastic to assist with sandbag barrier reinforcement, and water pumps. This material and technical assistance must be directly related to flood fighting operations. The Corps does not provide for life-sustainment needs, like tents, porta-potties, and potable water under its own authority. The Corps does not serve as the "lead" agency for flood fighting operations. State and local first responders have lead in all emergency operations. The Federal Government in total, and specifically the Corps, is supplemental to the state's efforts.

Public Law 84-99 provided the authority for Corps EM activities prior to and during this flood event.

After the state Emergency Management Agency has completed Preliminary Damage Assessments (PDAs), the Governor may request the President to issue a Federal Disaster Declaration. During the period between when that request is made and until the declaration (up

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[5] **ESF #3. "Public Works and Engineering" addresses provision of technical advice and evaluation, engineering services, contracting for construction management and inspection, contracting for the emergency repair of water and wastewater treatment facilities, potable water and ice, emergency power, and real estate support to assist the State(s) in meeting goals related to lifesaving and life-sustaining actions, damage mitigation, and recovery activities following a major disaster or emergency.**

DRAFT

to 10 days) the Governor may also request the Corps, under its 84-99 authority, to complete specific life sustaining missions such as clearing of roads or streams, restoration of control panels for lift stations, repair of electrical service to water pumps and providing generators to hospitals. With a Presidential Disaster Declaration any portion of those missions not completed within the 10 days after the Governor's request will be finished under FEMA's authority to assign missions to the Corps.

3.2 National Weather Service

The National Weather Service (NWS) is a federal agency under the National Oceanic and Atmospheric Administration (NOAA), which is part of the United States Department of Commerce. It has been providing meteorological forecasts and warnings since its original creation as the Army Signal Corps in 1870. The NWS was reorganized as the Weather Bureau under the Department of Agriculture in 1890, and became part of the Department of Commerce in 1940. The NWS operates more than 130 field offices nationwide, six regional offices, and other various centers.

The Hydrometeorological Prediction Center (HPC) provides forecast, guidance, and analysis products and services to support the daily public forecasting activities of the NWS and its customers, and provides tailored support to other government agencies in emergency and special situations. The HPC publishes Quantitative Precipitation Forecasts (QPFs)[6] twice daily, early morning and late afternoon/evening. The QPFs are then evaluated and used by the River Forecast Centers (RFCs) to prepare river stage forecasts. Thirteen RFCs are the NWS centers of expertise for hydrologic forecasting, and are tasked with providing a range of hydrometeorological data, including river stage forecasts for over 4400 locations along rivers in the Unites States. Each RFC provides these river forecasts to local Weather Forecast Offices (WFO) located across each Center's forecast area. After reviewing the forecast for accuracy, WFO forecasters publicly disseminate the forecast in both text and graphical form, and use it to compose flood watches, warnings, and advisories for forecast locations within their area of responsibility.

The Ohio River Forecast Center (OHRFC) located in Wilmington, Ohio is responsible for providing forecasts for 276 locations along the Ohio River and its tributaries, including the Cumberland River basin to Clarksville, TN. Cumberland River forecasts from the OHRFC are provided to the Nashville WFO for evaluation and public dissemination.

The Lower Mississippi River Forecast Center (LMRFC) located in Slidell, Louisiana is responsible for providing forecasts for the Ohio River below Smithland Locks and Dam, the Cumberland River below Clarksville, TN, and the lower Mississippi River from Cairo, IL to New Orleans, LA. Lower Ohio River forecasts are provided to the Paducah Weather Forecast Office for evaluation and public dissemination.

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[6] **Quantitative Precipitation Forecast (QPF) incorporate the surface and upper air analyses, radar data, satellite data, and model guidance in conjunction with information regarding satellite trends, precipitation and moisture availability estimates to develop an estimate of precipitation during a specified period and over a specified area.**

Both the NWS and the Corps have complementary missions that require the collection of meteorological and hydrological data. Both agencies recognized the parallel aspects of these missions and signed a Memorandum of Agreement (MOA) in 1991 that began a formal effort to cooperatively "develop modern, cost-effective, coordinated procedures and techniques for forecasting the status of the Nation's river systems and regulating the Nation's water control systems". The MOA provided a platform to improve information and real-time data sharing as well as to improve the collaboration between the two agencies. Under the agreement, the NWS will provide the Corps meteorological forecasts and both agencies will share their hydrological forecasts. The NWS has responsibility for dissemination of meteorological and hydrological forecasts and warnings to the public. The Corps may provide available project-related data to the public through web pages, taped messages, press releases or other means.

3.3 United States Geological Survey

The United States Geological Survey (USGS) is a federal agency under the Department of the Interior charged with providing reliable scientific data and research for a wide range of earth and life science disciplines. As part of its mission, it is responsible for collection and dissemination of hydrological data and information. During periods of flooding, this data is critical to the hydrological forecasts of the NWS and Corps and for the management of the Corps reservoirs. To accomplish this phase of its mission, Water Science Centers (WSCs) in each state maintain a comprehensive network of stream and precipitation gages. These gages provide real-time data that is primarily collected via satellite telemetry and disseminated to the Corps, NWS and the public. USGS collects manual stream flow observations multiple times a year at each gaging location to provide accurate conversion relationships between a river's stage and its flow, information critical to accurate water level forecasts and water management decisions.

The Corps and the USGS established the Cooperative Gaging Program in 1940 to partner together for effective funding, operation, and maintenance of gages vital to the Corps' reservoirs and water control management missions.

3.4 Tennessee Valley Authority

The Corps and the TVA have a unique relationship with respect to water management activities within the Tennessee, Cumberland, and Ohio River basins. Geographically, the Tennessee River basin falls entirely within the boundary of the Nashville District of the Corps of Engineers. However, following creation of the TVA by an Act of Congress in 1933, a sharing of water resources related responsibilities has been in place between the two agencies. In general, TVA handles all matters related to hydropower on the Tennessee River and the Corps operates and maintains the navigation features. LRN operates ten multi-purpose projects in the Cumberland basin. Nine of these ten projects have hydropower facilities. Likewise, in the Tennessee River basin, TVA operates 51 projects with 29 of those having hydropower facilities. The TVA River Operations Center located in Knoxville, TN, oversees water management activities for all these Tennessee River Basin projects.

The Tennessee and Cumberland Rivers are connected via the unregulated (no gates) Barkley Canal located in the lower portion of the Kentucky and Barkley pools, respectively. This canal requires close coordination (daily) between the two agencies in order to manage lake levels in

DRAFT

Kentucky Lake and Lake Barkley in a manner that not only supports requirements for those two projects, but also addresses downstream requirements on the Ohio and Mississippi Rivers. Under "normal" conditions LRN and TVA coordinate on operational requirements for the Kentucky and Barkley projects. TVA prepares an operational management plan on lake levels and project releases. Once the LRN and TVA water managers are satisfied with the various components of the plan, they independently carry out the necessary water management activities.

During high flow events on the Ohio and/or Mississippi Rivers that meet defined criteria based on the stage at the Cairo, IL gage, LRD WM takes control of the releases from both Kentucky and Barkley. This delegation of responsibilities was detailed in Section 7 of the Flood Control Act of December 1944 (58 Stat. 887) that reads in part as follows:

"This section shall not apply to the Tennessee Valley Authority except that in cases of danger from floods on the lower Ohio and Mississippi Rivers the Tennessee Valley Authority is directed to regulate the release of waters from the Tennessee River into the Ohio River in accordance with such instructions as may be issued by the War Department."

In 1947, the Secretary of War designated the Division Engineer, Ohio River Division, now the Great Lakes and Ohio River Division (LRD), as the War Department representative. This designation made LRD responsible for the issuance of instructions to TVA regarding the releases from the Tennessee River when flooding exists on the lower Ohio and Mississippi Rivers.

The Corps, TVA, and SEPA have a power operating agreement (Memorandum Of Understanding dated 1984) that involves the production and marketing of hydropower within the Cumberland River system. In general, the agreement addresses the balancing of flow between hydropower operations and additional operating objectives including navigation, recreation, and water quality. During high flow events on the Cumberland River, hydropower and other operating objectives becomes secondary and all efforts are focused on flood damage reduction designed to protect public health and safety and the protection of property.

DRAFT

4.0 EMERGENCY OPERATIONS SUMMARY

In accordance with Engineer Regulation (ER) 500-1-1, Engineer Pamphlet (EP) 500-1-1 and Great Lakes and Ohio River Division (LRD) emergency plans, response support duties are assigned to each District. For example: Nashville District (LRN) has responsibility to provide assistance to Tennessee and Louisville (LRL) has responsibility to provide assistance to Kentucky.[7] The LRD Emergency Operations Center (EOC) began coordination with both the LRL EOC and LRN EOC on April 24, the weekend prior to the May 1 flood event. This coordination activity was initiated as a result of significant weather forecasted to the west of the Division's Area of Operations (AO) and the potential impacts within the State of Tennessee and Commonwealth of Kentucky over the weekend of April 24-25. A major spring storm system moved through the central United States, bringing widespread severe weather south of the Ohio River and rainfall of 1 to 3 inches across the Ohio River Valley and southern Great Lakes. The heaviest rainfall fell on Sunday, April 25 in northwestern Ohio and southeastern Michigan, where 2 to 3 inches of rain fell.

Based on the NWS LMRFC forecast and Cairo stage, the criteria were met for flood control operation and LRD WM notified TVA, LRN WM and the LMRFC that LRD WM was assuming direction of Kentucky and Barkley Lakes. Note: As per established policy and proven operational guidance contained in the Water Management Control Plan, the criteria are met when the Cairo stage is 35 feet and forecasted to exceed 40 feet (flood stage).

Consistent with EM's Concept of Operations and given the potential for adverse impacts, the LRD EOC and appropriate subordinate Districts (LRL and LRN) elevated their respective EOC from "Normal" (Day-to-Day Operations) to "Emergency Watch" (Extended hours of operations and/or EM Staff augmentation) to monitor the developing situation.

As the week progressed prior to the flash flood event of May 1, daily routine LRD WM Reports indicated another heavy rainfall event based on the NWS 5-Day Quantitative Precipitation Forecast (QPF). As the situation began to unfold throughout the week, the LRD EOC operations tempo began accelerating and augmented with appropriate LRD Crisis Action Team (CAT) members. On Thursday April 29, daily coordination teleconferences between HQ USACE, LRN EOC, LRL EOC, the Mississippi Valley Division (MVD) EOC and Memphis District (MVM) EOC were imitated.

During this heightened preparatory phase, all these EOCs were pushing information back and forth on weather, basin conditions, equipment needs, pre-identifying flood-fight teams, Corps LNOs as well as Emergency Support Function (ESF#3) Team Leaders to staff critical Command & Control (C2) positions at the FEMA IV Regional Response Coordination Center (RRCC) in Atlanta, GA, the Incident Management Assistance Teams (IMAT) designated for response for Federal assistance from Tennessee and/or Kentucky. Corps LNO's deployed to the state EOC is deployed under existing USACE Authorities upon receiving a state's request. Additionally, pre-identification by EOCs of Planning and Response Teams (PRTs) in anticipation of FEMA

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[7] **See also Section 3 for further description of the duties and responsibilities of various agency elements.**

DRAFT

mission assignments were proactively undertaken for the following mission assignment areas: Debris, Commodities, Temporary Emergency Power, Infrastructure Assessment, and Temporary Housing. FEMA ultimately assigned the following missions to LRD: Regional Activation, National Water Mission (executed by the New England District for bulk procurement), Debris Technical Assistance, Water-Waste-Water Technical Assistance, Project Worksheets, and Geographical Information System (GIS) support to ESF#5 (Electronic mapping and data base products). Minus the Regional Activation managed by LRD, remaining mission assignments were delegated the Nashville District.

It should be noted, indicative of ongoing preparatory collaboration was a master planning Disaster Preparedness Workshop that occurred April 19-21, 2010, which LRN initiated. This workshop included LRD EM and seven LRD District EM sections, the Memphis District, two Madison county representatives, FEMA Region IV (Atlanta), and the TVA. Such workshops allow for face-to-face recognition, cross-training, collaborative dialogue and awareness of operational processes and techniques.

It should be further noted that constant communication and coordination occurs throughout EM sections of Corps and State counterparts. LRN EM had increased communications with the Tennessee Emergency Management Agency (TEMA) beginning the weekend prior, April 24-25, 2010, due to early concerns of pending developing weather conditions, intensified with the arrival of the District LNO at the state EOC on May 2, and continuing through the now ongoing recovery phase.

The following Emergency Management timelines capture significant flood fighting activities of executing Districts, Nashville and Louisville, during this historic flash flood event. To initiate flood fight activities under taken by the Corps under Public Law 84-99, the Nashville District Commander verbally declared a flood emergency May 1, 1300 hours and the Louisville District Commander declared the same May 2, 1400 hours, with written documentation following the morning of May 2, and, May 3, respectively. Operational EOCs included LRN, LRL, and Memphis District (MVM) as well as both LRD and the Mississippi Valley Division (MVD) EOCs.

4.1 LRN Timeline: Interaction between LRN and TEMA

Summary of activity:

1 May 2010 (Saturday)

- 1200 hours: LRN EM Chief, LRD EM Chief held a conference call to discuss increased activation levels, to Level II, of LRN EOC. Contacted LRN Commander and he gave verbal approval.
- 1230 hours: The Tennessee EOC (SEOC) activated to Level III[8] activation.

[8] **This level is assumed as the situation deteriorates further (i.e., with the issuance of tornado warnings, notification of impending emergency). During this phase TEMA staff notifications are made, appropriate state and local government/agency notifications are made, Emergency Public Information (EPI) is broadcast as appropriate, and the TEMA Director may elect to implement the Tennessee Emergency Management Plan (TEMP) if required.**

- 2000 hours: Tennessee Emergency Management Agency (TEMA), which is the agency, operates from the State EOC, contacted LRN Chief, EM and requested 10,000 Sandbags. The LRN EM Chief indicated that we had 2,000 sandbags on hand. They requested delivery of the 2,000 and will take the other 10,000 sandbags when they arrive.
- 2005 hours: LRN EM Chief contacted the Resource Manager (RM) at Barkley to coordinate exchange of pre-positioned sandbags.
- 2200 hours: Sandbags delivered to TEMA (Nashville).

2 May 2010 (Sunday)

- (local flooding imposed additional two hour travel time for LRN EOC personnel to reach facility)
- 0800 hours: First EOC personnel man LRN EOC. (LRN WM personnel augmented LRN EOC as initial elements of LRN Crisis Action Team (CAT)).
- TEMA confirmed that 6000 sandbags had been delivered to Nashville, TN and 6000 sandbags went out to Jackson, TN for staging purposes.
- 1130 hours: LRN EM Liaison at alternate State EOC (SEOC) and met with TEMA officials who informed that the problem they had earlier in the SEOC that morning was under control and they would be moving back to the State EOC.
- 1230 hours: LRN State LNO arrived at State EOC off of Sidco Drive (primary state EOC).
- 1300 hours: United States Coast Guard (USCG) came by and informed LRN EM Liaison of a situation of concern at the State Data Center on 5th Ave in downtown Nashville. They were concerned about the flooding and wanted instruction on whether they were in danger of flooding and needed to relocate their office or if they were out of harm's way.
- 1310 hours: Contacted LRN EM about flooding problem and began working on a solution via LRD/LRL.
- 1400 Hours: LRN EM Liaison contacted by USCG. Concern is that approximately 15 miles up the Cumberland River at Trinity Ship Yards, there were some newly built barges that if the flooding continued, increased strain on their mooring lines could cause them to break free and run down the river into Cheatham Lock and Dam. The roads leading to the barges were flooded and impassible. The LRN EM Liaison contacted the Chief, LRN Navigation Branch. LRN Navigation contacted the USCG and recommended that a local tow company on the river could possible moor besides the barge and secure. There were no local tow companies in the area. Barges were monitored, and did not break free.
- 1430 hours: The State Data Center had 1000 sandbags and a number of volunteers on the way and they needed to have someone tell them where they needed to be placed. The State Data Center provided the LRN EM Liaison contact information so that he could get in touch with them.
- 1500 hours: LRL contacted the LRN EM Liaison about the Data Center's situation. LRL was provided the location and Mr. Jordan's (TN State Data Center director) information and advised they would attempt to help them from there.

DRAFT

- 1600 Hours: TEMA received calls from the local media stating that the public is concerned about a dam failure at J. Percy Priest. LRN EM Liaison received question from TEMA representative regarding concerns at J. Percy Priest Dam. LRN EM liaison contacted LRN WM and dismissed the concerns by verifying that J. Percy Priest was in fact operating correctly. LRN EM Liaison also received a question regarding problems with the tainter gates at Old Hickory Lock and Dam. LRN EM Liaison discussed issue with LRN WM and it was concluded that the gates are operating correctly.
- 1600 Hours: LRN EM Liaison received a question concerning the anticipated pool elevation of Old Hickory Lake (Cumberland River Mile 22.52). The Tennessee Department of Environmental Conservation's (TDEC) concern is the effect of the higher pool on the West Wilson Utility District. LRN EM Liaison contacted LRN WM and was informed of the anticipated pool elevation. This information was passed to TDEC.
- 1613 hours: TEMA Situation Report (SITREP) released. SITREP stated the Cumberland River was at gage level 44.6 feet, elevation 412.7 feet. The State Data Center had on hand the requested sandbags and labor at this point to construct a berm around their facility located on 5th Ave.
- 1700 hours: LRD EM called the LRN EM Liaison to ask if they had spoken with LRL about the potential for the Data Center's to flood. Informed LRD that contact had been made and the actions were discussed.
- 1745 hours: LRN EM directed us to have Metro (City of Nashville/Davidson County government) EM get in touch with LRN Engineering and Construction division (EC) regarding Metro Center Levee conditions. The Metro EM was out on patrol but Nashville EOC did finally contact him via cell phone and he was able to reach LRN EC. (Resulting in LRN providing technical assistance in sandbagging Metro Levee that night).
- 1800 hours: Out briefing of the day shift at the State EOC. The LRN EM Liaison exchanged contact information with the USCG.
- 1900 hours: The LRN EM Liaison Departed the State EOC and met with LRN EM to discuss day's events. State went to minimal State EOC manning that night.
- 2100 hours: LRN personnel departed LRN EOC.

2150 hours: TEMA requested assistance from LRN to provide technical assistance to Opryland Levee engineers. LRN dispatched its Chief, Technical Design Branch and alternate Dam and Levee Safety Officer, who observed several sand boils, heavy and worsening piping in several locations, and indications of underseepage. He advised Opryland Levee engineers that sandbags were needed to shore up the levee and suggested that they obtain the drawings to further ascertain levee structural integrity concerns.

3 May 2010 (Monday)

- 0845 hours: LRN EM Liaison arrived at SEOC.
- 0900 hours: Cumberland River level is now 51 feet and will remain so until sometime Wednesday.
- 0900 hours: The Opryland Hotel has been flooded and evacuated. Metro Center has been flooded and evacuated. Several neighborhoods in Middle Tennessee have been flooded and evacuated. Nashville Water Treatment is down. Harrington Water

DRAFT

Supply is down (water treatment facility); they are purchasing from water West Wilson (other water treatment plant). Harpeth Valley Water is at half capacity due to leaks and breakages. There are water line breaks all over Middle Tennessee. East Tennessee is not reporting any water problems.

- 0900 hours: Started working with TEMA Support Branch on getting 100,000 sandbags delivered to Nashville.
- 0900 hours: A request for the discharge rates at the projects (upstream of Nashville, TN) was made by a TEMA Emergency Support Coordinator (ESC) member. Also, the forecasted crest of the Cumberland was requested as well. Contacted LRN WM and they provided sufficient information. LRN WM stated that the Cumberland was forecasted to crest this afternoon at 51.5 feet. The discharge rates were as follows:

    - Old Hickory = 212,000 cubic feet per second (cfs)
    - J. Percy Priest = 5,000 cfs
    - Cordell Hull = 125,000 cfs
    - Center Hill = 0 cfs turbines (250 cfs sluice gates)
    - Dale Hollow = 50 cfs turbines (25 cfs dam gate)
    - Wolf Creek = 0 cfs turbines (280 cfs dam gates)

- 1000 - 1200 hours: There was another request for the expected crest of the Cumberland River at Nashville, TN and an update on the discharge rates at the projects along the Cumberland (upstream of Nashville, TN). The forecasted crest was to 51.5 feet by 1800 hours. LRN WM provided the discharge rate for the following projects:

    - Old Hickory = 212,000 cfs
    - J. Percy Priest = 5200 cfs
    - Cordell Hull = 125,400 cfs
    - Center Hill = 0 cfs turbine (250 cfs sluice gate)
    - Dale Hollow = 50 cfs turbine (25 cfs dam gate)
    - Wolf Creek = 0 cfs turbine (280 cfs dam gates)

- 1345 hours: Another ESC member wanted to clarify the forecasted crest for the Cumberland River in downtown Nashville. They wanted to know what the Corps was forecasting. They stated that the NWS is forecasting a crest of 53 feet by 1900 hours or 2000 hours on May 3. The LRN EM Liaison told him that the official forecasts come from NWS.
- 1400 hours: Coordinated a meeting between Director of TEMA, Governor of Tennessee, LRN Commander, LRN Deputy Commander, and the Crisis Management Team (CMT) to discuss the Corps' ideas and strategy for water releases at projects that are upstream of Nashville, TN. Also, to discuss Clarksville, TN deteriorating conditions.
- 1500 hours: Released the latest news from the Corps regarding releases at several area dams. Explained along with TEMA the whole process about water management and how these dams help to accomplish the goal by strategically releasing certain amounts of water at specific times.

DRAFT

- 1500 hours: Public Information Officers (PIOs) are receiving calls from the New York Times and the BBC as the story of the flood goes national and even global. Rumors have begun about future flooding and dam releases that have triggered an influx of civilian calls. Other calls are being received regarding financial aid to replace damaged property. PIOs are working on a situation report for the governor's 1800 hours brief.
- 1500 hours: Cumberland River level is now 51.5 feet. Nashville Metro Water/Public Works Commissioner is issuing a Mandatory Water Conservation Order at 1800 hours. Commissioner will coordinate press conference with TEMA Public Information Office (PIO). Metro is operating at a limited capacity.
- 1500 hours: If the river level reaches 52.5 feet, Nashville will lose all water. Harpeth Valley, which supplies Brentwood and Franklin, is on generator power and is at a very limited capacity. Madison and West Wilson are still fully operational and will be able to supply some Nashville areas. Metro Police Department (PD) is restricting access to Metro Center. Metro Water Supply is in touch with the LRN EOC to WM to help determine the proper amount of water to release from the dams in order to ensure that the dams remain safe and the flood levels remain as low as possible.
- 1500 hours: Corps has 100,000 sand bags en route Nashville SEOC from the storage facility at LRN's Lake Barkley project. TDEC's Water Supply Branch, contacted LRN WM to receive help to determine the proper amount of water to release from Dams in order to ensure that the dams remain safe and the flood levels remain as low as possible. (LRN EM Liaison was to the contact go between for the information.) 1735 hours: TEMA SITREP Released.
- 1735 hours: LRN LNO departs State EOC, returns to LRN EOC.
- 1800 hours: LRN EOC verified with State EOC 50,000 sandbags had been successfully delivered to TEMA on Sidco Dr. Additional 50,000 were stored at Old Hickory.
- 1900 hours: LRN EOC confirmed that sandbags were physically on the ground.
- 2030 hours: Conference call with Crisis Management Team (CMT).
- 2041 hours: Conference call with White House National Security Staff, providing SITREP from the LRN District Commander. The LRN District Commander conducted subsequent interview with local television station, Channel 2.

4 May 2010 (Tuesday)

- 0700 hours: LNO arrived at TEMA (State EOC) to check on the status of Sandbags. According to TEMA Support Branch they still had 27,000 sandbags left at TEMA SEOC, Sidco Dr, and the remaining 50,000 sandbags were at Old Hickory.
- 0845 hours: Tennessee Department of Environmental Conservation requested an update on Cheatham Dam. They had heard rumors that it had been breached. Contacted Corps Cheatham power house during event. The Corps clarified that the rumor was not true. The Cheatham Lock and Dam is designed to be overtopped and there were no serious issues to report. 0900 hours: Cumberland River level at Nashville is 48.5 feet and at Clarksville is 62.5 feet and dropping slowly.
- 0900 hours: Metro Center Levee has integrity concerns and sand bagging is being completed, have sand bags approx 4 feet high. Metro Center has been evacuated and remains evacuated/controlled. Omohundro water treatment plant is operating at 100

DRAFT

percent capacity. The water storage tanks are losing about 15% of water capacity a day. Omohundro is continuing to have sand bags put around it to keep from flooding. There is a water conservation order in place for citizens, acquiring large amounts of bottled of water in anticipation that this water issue may last a couple of weeks. County was working on a hazmat situation on N 1st with flooding and multiple oil companies off the river bank. TDEC/TEMA has been advised. Large evacuations took place including Wyndham Resorts and Opryland Hotel, and many smaller facilities/locations. TEMA is working on a plan for opening 2 Disaster Assistance Centers Tuesday. Since 1600 hours, TEMA has completed 25 rescue calls (each call, not number of people).

- 1600 hours: Spoke with TEMA about having the LRN Commander attend a conference at the Office of Emergency Management (OEM) to discuss the Corps actions during the flooding. The conference was scheduled to be at 1700 hours. Contacted LRN EM and LRN Commander and LRN Deputy Commander were already informed.
- 1728 hours: TEMA SITREP Released.

5 May 2010 (Wednesday)

- 0600 hours: Members of FEMA IMAT (Incident Management Assistance Team) arrives at the SEOC.TEMA Director has increased the level of operations at the State EOC to Level 2. (TEMA levels are the inverse of Corps' levels; i.e. TEMA level 2 = Corps level III, TEMA Level 2 occurs once a major disaster occurs, Level 3 occurs at a declared state emergency). The President has signed the Federal Disaster Declaration, which now includes the following six counties: Cheatham, Davidson, Dyer, Hickman, Montgomery, and Williamson. FEMA is ramping up its presence in the state and is working on plans to set up their Joint Field Office (JFO) but has not yet announced when the JFO will be established.[9]
- Catastrophic flooding continues in multiple Tennessee counties. Damage assessment has begun and is moving from East to West as the waters recede. Rescue missions have significantly diminished. TEMA is now focusing mainly on water distribution, including receiving EMAC and FEMA water at the Smyrna Logistical Staging Area and distributing that water as requested and where needed.
- 0900 hours: Cumberland is now at 48.2 feet in Nashville, 58.5 feet in Clarksville, which is still significantly above flood level. The river has dropped over four feet since the crest, but is flattening out due to further dam releases. There is a state debris strike team meeting downtown today.
- 1500 hours: Cumberland is now at 47.5 feet in Nashville.
- 1635 hours: TEMA SITREP Released.
- The EOC is still activated at a level II.

[9] **This level is reached when the emergency has been initiated (i.e., the actual occurrence). TEMA staff reports to the SEOC to commence state emergency operations, appropriate ESCs are tasked to respond to the SEOC, and TEMA field personnel are deployed to assist local governments (i.e., full emergency operations are in effect). Limited federal assistance may be required at this point.**

DRAFT

- Visited TEMA SEOC to get an update on sandbags. The currently have 26,000 sandbags still at TEMA SEOC on Sidco Dr. There are still 50,000 sandbags stationed at Old Hickory.
- Recovery Phase begins.
- 2030 hours: HQ USACE ESF #3 Team Leader on Ground.

4.2 LRL Timeline: LRL and Kentucky Lake/Lake Barkley

Three of the four LRD districts, having projects in the Commonwealth of Kentucky, were fully engaged in this event. By the end of the flood event, a total of 36 LRL employees responded to this event.

Summary of activity:

2 May 10 (Sunday)

- 0700 hours: LRL EM received a call from the KY EOC concerning a private dam that about to fail. KY DEM was gathering information on the dam's problems and was interested in the Corps inspecting the dam. The request was dropped after it was determined to be a low impact low risk dam. The two families affected downstream were evacuated as a precaution.
- 1400 hours: Kentucky EOC declared activation Level II, preparing for flood fight response and assistance to Commonwealth of Kentucky.
- 1600 hours: LRL Commander declared a Flood Emergency for LRL.
- 1630 hours: KY DEM requested 10,000 sandbags for Pendleton County.
- 1700 hours: LRL EM assisted the Tennessee State Data Center in Nashville in their flood fight preparations to protect the facility.
- 1730 hours: Sandbag destination changed to Frankfort State DOT Office
- 1900 hours: Sandbags arrived at Frankfort DOT Office.
- Numerous calls and phone meetings between the KY DEM throughout the night.

3 May 10 (Monday)

- 0900 hours: Kentucky EOC increased its activation to Level III as of late May 3 due to the severe weather. Kentucky EOC requested a FEMA LNO, and a representative is enroute.
- 0900 hours: Conference call with the State EM Director, County Judge of Livingston County and their staffs and the Louisville District EM, LRD EM and WM concerning releases from Lake Barkley. The concern was will the releases affect the communities downstream of Barkley Dam. The project releases had been coordinated with the NWS and TVA.
- 1200 hours: LRL EM discussed with KY EOC the option of having a COE LNO in the KY EOC. The KY Director agreed but not till morning.
- 1500 hours: LRL EM received a call from KY EOC concerning emergency evacuations underway downstream of Barkley Lake.
- 1800 hours: Conference call with LRD EOC and WM, NWS, LRN EOC, and LRL leadership discussing Barkley Lake. Releases were lowered as result of

DRAFT

teleconference, evacuations at Iuka continued.

4 May 10 (Tuesday)

- The Commonwealth of Kentucky requested the President to declare Kentucky a Major Disaster Area to help recover from heavy rains over the weekend that caused at least four deaths and caused extensive damage.
- Damage caused by the rains was estimated to exceed $6.2 million, more than the $5.2 million minimum needed to seek a federal disaster declaration.
- There were several monitored streams throughout Kentucky, as well as the Ohio River that were rising significantly. LRD, LRN and TVA coordinated the timing of flow rates and releases from Kentucky and Barkley Lakes to minimize flood damages on the lower Ohio River.
- 0900 hours: A phone call from the KY EOC and the Livingston County Judge concerning the river predictions. The elevations the NWS was publishing and what they were seeing on the ground were not matching. Livingston County Officials continued to monitor the situation using a staff gage downstream of the dam. An unofficial agreement between LRL EOC and Livingston County officials determined that if the river doesn't do what has been predicted they are to call the Louisville District Emergency Management, 24/7. Further, Louisville sent an individual from one of the flood fight teams to assist and advise the County on flood fight preparation measures at Smithland on the Ohio River.
- 1000 hours: LRL LNO arrived at the KY EOC.

5 May 10 (Wednesday)

- 0900 hours Daily Strategy call between KY EOC and LRL EOC. The Corps, Kentucky Division of Emergency Management (KYEM), the Kentucky Division of Water (KYDOW), as well as other state and local emergency officials, continued to monitor water levels behind all dams and levees across the Commonwealth.
    - Kentucky Lake/Lake Barkley releases continued to be monitored. The Corps closely monitored the release and provided personnel at Smithland in Livingston County downstream of the dam. The County Judge and County Emergency Management embraced Corps efforts and were pleased with results of the response.
    - Outflows from Kentucky Lake decreased, with Barkley Dam flows holding steady to balance risks for the Cumberland/Tennessee and Lower Ohio Valley. The scheduled average flows were 291,000 cfs from Kentucky Dam and 232,000 cfs from Barkley Dam, reduced to 168,000 cfs and 182,000 cfs respectively on Thursday. LRD directed reduced flows in concert with the Ohio River crest to reduce Cairo peak stages to the greatest extent possible.
    - 1530 hours: at the request of the KY EOC a Flood fight team sent to Bowling Green to help in the constructing a temporary levee around a water treatment facility. This facility supplies potable water to six counties.
    - 0030 hours: Phone call from the Flood Fight Team in Bowling Green. Temporary levee complete and holding. River levels are five feet up on the levee already. Crest predictions indicate the levee should have two feet of

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freeboard. EM recommended adding another two feet in height and four feet at the base. Was completed by 0600 hours the next morning.

6 May 10 (Thursday)

- 0900 hours: Call. The Corps, Kentucky Division of Emergency Management (KYEM), the Kentucky Division of Water (KYDOW), as well as other state and local emergency officials, continues to monitor water levels behind all dams and levees across the Commonwealth.
    - LRL flood fight teams active and deployed to continue assistance in flood fight efforts.
    - Continuous teaming with Nashville District, the National Weather Service and Tennessee Valley Authority in accordance with established protocols. Barkley Lake was expected to crest near or at 369.4 ft on May 7th. The pool of record is 370.04 feet set in 1984.
    - Discharges from Kentucky and Barkley Lakes remain between 100,000 – 150,000 cfs over the next 7 days.
- The Captain of the Port (COTP), based in Paducah, KY, was reevaluating whether to extend the river closures to navigational traffic on the Cumberland River to the 14 or 27 mile points due to high water conditions. Barkley to remain closed to navigation traffic.
- 1300 hours: At the request of KY EOC six pumps and one flood fight team were dispatched to Wayne County, KY.
- 1700 hours: Team arrives at Wayne County and assesses the situation. Advises the County what equipment is necessary to place the pumps and where.
- 2230 hours: Pumps arrive and County begins placement of the pumps.

7 MAY 10 (Friday)

- 0800 hours: Dispatched additional flood fight teams to Brookport, IL.
- 1600 hours: At the request of the Illinois EOC eight pumps and 50k sandbags were sent to Brookport to assist in the flood fight efforts there.

10 May 10 (Monday)

- Lower Ohio-Mississippi River Flood Control Strategy continued to be successful.
- River Conditions had minor flooding continuing along the lower Ohio River below Newburgh Lock and Dam. Stages along the lower Ohio River from Paducah to Cairo continued to slowly fall in response to recent flow reductions from Kentucky and Barkley Lakes.
- Kentucky and Barkley Lakes were still under active management for flood control and remained so throughout the week. Water levels at Barkley Lake crested and were forecast to fall; and Kentucky releases were targeted to increase this week between 120,000—200,000 cfs. Outflows from Barkley Lake were targeted to be between 100,000 – 150,000 cfs over the next 7 days.

DRAFT

11 May 10 (Tuesday)

- Seven KY counties were declared Disaster Areas by the President. The declaration includes Individual Assistance and Public Assistance. Thus far, no Corps assistance is requested.
- Lower Ohio-Mississippi River Flood Control Strategy continued to be successful in preventing multiple communities from Smithland, KY, to Brook Port, IL, which is downstream from Paducah, from flooding. This strategy incorporated water management operations and flood fight activities.
- Progress continued to improve the area and concerns were being diminished.

13 May 10 (Thursday)

- Lower Ohio-Mississippi River Flood Control Strategy continued to be successful.
- Progress still continued to improve in the areas. Outflows from Kentucky Dam were scheduled to slowly decline from a daily average of 147,000 cfs to a daily average of 115,000 cfs by Saturday. Outflows from Barkley Dam were scheduled to hold steady at 118,000 cfs through May 14, 2010. Without additional rainfall, pool levels were projected to fall below elevation 365.0 feet and reach the guide curve elevation of 359.0 feet on Tuesday.

26 May 10 (Wednesday)

- The KY 2010 May Flood situation has significantly improved. Predicted weather forecasts continue to alleviate any concerns for the District on the Memorial Day weekend and into early following week.
- The flood control lakes were falling as much as allowable. Outflows from Kentucky Dam were scheduled to gradually be reduced, reaching 28,000 cfs by Saturday. Outflows from Barkley Dam were also scheduled to be gradually reduced this week, reaching 17,000 cfs by Sunday. Without additional rainfall, pool levels were projected to reach the guide curve elevation of 359.0 feet.

3 Jun 10 (Thursday)

- No concerns remain for these projects.

Event was concluded.

4.3 Additional Timelines

Refer to Appendix D for the timeline for Corps (Great Lakes and Ohio River Division (LRD) and Nashville District (LRN)) Water Management.

Refer to Appendix E for the timeline for the National Weather Service (NWS) Ohio River Forecast Center (OHRFC) and the Nashville Weather Forecast Office (WFO).

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5.0 CORPS ACTIONS

5.1 Summary of Corps Water Management Operations

The Corps operated all flood risk management projects to reduce downstream flooding and initiated emergency management operations to provide assistance to state and local governments. The vast majority of the rainfall occurred in drainage areas uncontrolled by Corps flood risk management projects. During the event, the full storage capacity of Wolf Creek, Dale Hollow, and Center Hill dams was unable to be used because the rain fall was concentrated in drainage areas downstream of the projects. The J. Percy Priest dam, located just upstream of Nashville, was nearly overtopped during this event. Its flood storage capacity was exceeded requiring operation of the spillway gates to avoid overtopping. The navigation project, Cheatham Lock and Dam was overtopped and personnel were evacuated from the project by boat. Spillway gate operations were required at the navigation projects of Cordell Hull and Old Hickory to prevent overtopping and losing control of water releases. At the height of the event, Corps personnel were making minute-by-minute decisions for the operation of eight projects in an extremely dynamic and dangerous environment. Preliminary analysis indicates that operations of the Corps projects reduced the Cumberland River flood crest in Nashville by approximately five feet.

A detailed timeline of the LRD and LRN WM activities is provided in Appendix D. Appendix D also contains a chronological summary of the LRD and LRN communications with the NWS, TVA, and Metro Water Services. Appendix F contains plots and tables for project discharges, pools, and control gages. Lessons Learned Number 27 in Appendix H also provides a chronological summary of the water management actions taken during the event. The following section provides a brief summary of the actions taken by Corps WM during the event.

The Corps WM routinely monitors weather information on a daily basis. One of the primary products monitored is the NWS's QPF which is issued twice a day by the HPC. On Tuesday, April 27, LRD WM noted in its Early Morning Weather and River Update, that the next rainfall event was predicted by the NWS 5-Day QPF to begin on the coming Friday. On Wednesday, April 28, LRD WM noted the magnitude of the 5-Day QPF in the Cumberland Basin and began monitoring the storm. The NWS QPF indicated a rainfall event for May 1 and 2nd with forecast totals of 2 to 6 inches stretching from Louisiana north through Tennessee, Kentucky and southwestern Ohio. The Early Morning Weather and River Update published by LRD discussed the potential for this rainfall event.

The 3-Day NWS QPF, Figure 10, published Thursday morning, April 29, continued to show a significant rainfall event with slightly higher amounts over a wider extent. At this time LRD WM issued a Flood Potential Update to advise LRD senior leaders and the Nashville District of the rainfall event. In response, LRN WM made the decision to reduce the pools on the mainstem navigation projects in advance of the storm. This action resulted in lowering the lake levels at Cordell Hull and Old Hickory approximately 0.5 foot and the lake level at Cheatham approximately 1.0 foot, which placed the projects in a better position to manage for the forecasted rainfall totals. Personnel began lowering Kentucky and Barkley Lakes earlier in the week in response to the prior weekend's rainfall. The actions to reduce the lake levels were completed Saturday morning, May 1, prior to the initial rainfall.

DRAFT

The 3-Day NWS QPF, Figure 11, published Friday morning, April 30, showed increased 5-day rainfall totals of up to 7 inches with a high amount of 7.8 inches in central Tennessee. Widespread 2 to 6 inch totals were forecast over the southeastern US stretching into southern Illinois, Indiana and Ohio. Rain totals of 3-4 inches were forecast for the three day period starting on May 1 (Figure 12), in a band over western Tennessee and Kentucky. Subsequently, the 3-day QPF issued on May 2 (Figure 13) included rainfall totals of 2 to 4 inches with a high amount of 4.65 inches in a wide band spanning most of western and central Kentucky and Tennessee. In response, LRD, LRN and TVA evaluated the impact of the forecast rain on the Tennessee-Cumberland-lower Ohio River system. Even with the forecast rainfall, the LRD and LRN WM offices concluded that the flood control projects could handle the storm. Although the NWS forecast did not indicate that levels on the Ohio River would be reaching the criteria for LRD to take direction of Kentucky and Barkley Lakes (35 feet at Cairo, IL with a NWS forecast of 40 feet or greater), LRD WM initiated actions for the Division and Districts to operate over the weekend.

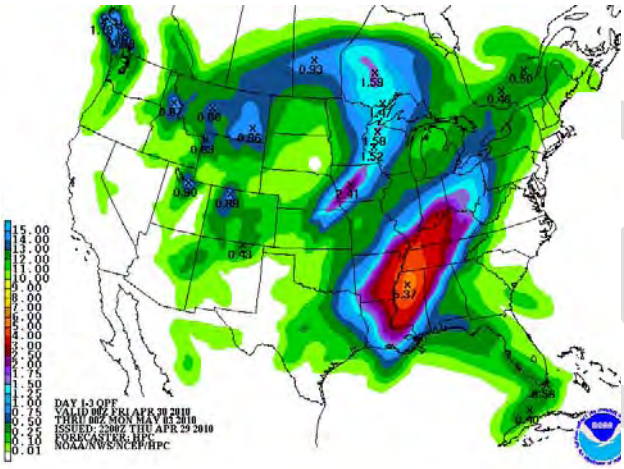

Figure 10 – NWS QPF published on April 29, 2010

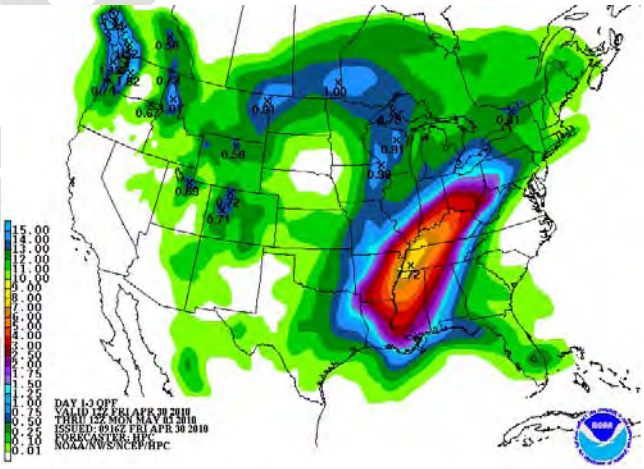

Figure 11 – NWS QPF published on April 30, 2010

The rain began falling Saturday morning. The 3-Day NWS QPF, Figure 12, once again showed increased forecast rainfall totals of up to 8 inches with a high amount of 8.6 inches in central Tennessee. Widespread 2 to 8 inch totals were forecast over the southeastern United States stretching into southern Illinois, Indiana and Ohio. On Saturday morning at 1000 hours, the hydropower unit at J. Percy Priest and one of three units at Center Hill were brought on line based on observed radar precipitation amounts and concern that the Stones River and Caney Fork River watersheds were going to receive excessive rainfall. These units ran the remainder of the day. Center Hill had eight hours of hydropower generation scheduled for Saturday; however, the action to keep one unit operating for the remainder of the day was taken to conserve pool storage and to manage the lake level in accordance with the Interim Risk Reduction Measures (IRRM)

pool restrictions placed on this Dam Safety Action Classification (DSAC) I[10] dam. The Center Hill pool restriction is 630 feet above mean sea level (msl) in the summer and no lower than 618 feet in the winter. The normal lake elevations range from about 648 feet in the summer to about 631 feet in the winter. Four of the six hydropower units at Wolf Creek, also a DSAC I dam, had been operating around the clock in response to the rain that fell the week before this event. These units continued to operate and to manage the lake level in accordance with the Interim Risk Reduction Measures (IRRM) pool restriction of a target elevation of 680 feet. The pool at Dale Hollow was at elevation 650.16 and was operating one hydropower unit around the clock for lake level management. The operation of the hydropower helped reduce pool levels.

Based on the 48 hour forecast rainfall, releases from Kentucky and Barkley Lakes were increased from the previous day's release schedule to a maximum of 106,000 cfs from Kentucky and 63,000 cfs from Barkley. With this new schedule, the lakes were forecast to crest at 363.9 ft on May 5. The increased releases were designed to further lower the pools prior to the arrival of the inflow expected by the rainfall.

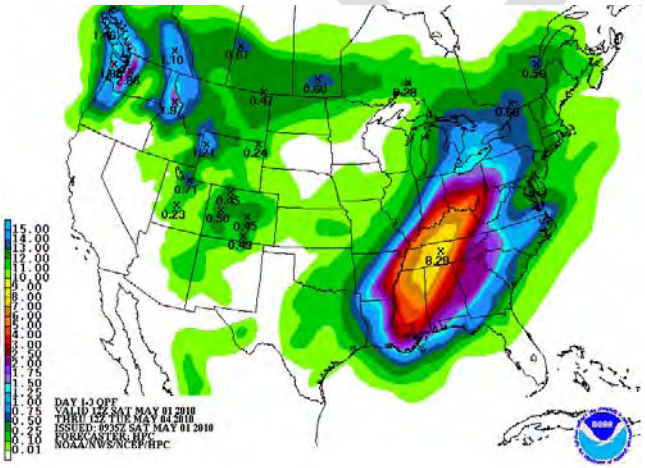

Figure 12 – NWS QPF published on May 1, 2010

As the rainfall increased in intensity on Saturday, and runoff from uncontrolled local watersheds entered the Cumberland River, the Old Hickory project initiated a series of spillway releases at 1200 hours and by 2300 hours the combined turbine and spillway discharge from Old Hickory had reached 75,000 cfs. By limiting the Old Hickory release to 75,000 cfs, an additional 15,000 cfs of channel capacity at Nashville was reserved for releases from the J. Percy Priest project and the uncontrolled area between Old Hickory and Nashville. During crop season (April 15 to

[10] DSAC I classified dams are unsafe and are urgent and compelling because they have confirmed dam safety issues that require immediate actions to reduce the risk of catastrophic dam failure. The DSAC rating is characterized by a dam being critically near failure under normal operations and certain to fail if actions are not taken immediately or within a short time frame to correct the unsafe condition. A Corps Dam can be classified as DSAC I also because of extremely high risk from a combination of life or economic consequences when the probability of failure is extremely high.

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December 15), the control flow at Nashville is 54,000 cfs (stage 26 feet). LRN WM[11] made the decision to apply the flood season (December 15 to April 15) control flow of 90,000 cfs (stage 35 feet) at Nashville. This action was taken in an effort to keep the Cumberland River from reaching flood stage (40 feet) at Nashville and to conserve surcharge pool storage at Old Hickory. During the period from noon to midnight on Saturday, May 1, the river stage at Nashville increased from 20.79 feet to 34.52 feet.

By early Saturday morning, LRN had completed lowering Cheatham pool 1 foot to better posture the project to respond to the significant increases to inflow expected by the rainfall. In less than 12 hours, by approximately 1900 hours on Saturday, the Cheatham Lock and Dam project went to "free flow". This means that the spillway gates were lifted out of the water and the river was no longer restricted, thus the project had no ability to exercise control over water levels. The Cheatham Lock and Dam design allows overtopping of the lock and spillway gate section without threat of failure of the dam. The Power Plant is at a higher elevation and does not become inundated during river levels such as those observed during this event.

> As the river level at Cheatham Lock rose quickly on Sunday a group of dedicated Nashville District employees worked tirelessly to salvage equipment from the lock building and move it to higher ground. During this process the river came up so quickly that the lock employees had to be evacuated to safety by team members from the Cheatham Natural Resource Manager's Office. The Cheatham Resource Manager, working with rangers from his staff shuttled staff and critical equipment to safety. During this same time period, one Cheatham Lock employee lost his personal vehicle to the flood as he assisted fellow employees moving their vehicles to safety.

The criteria to initiate a lower Ohio-Mississippi River flood control operation were met on Saturday, May 1. Based on the LMRFC forecast and Cairo stage, the criteria were met for a flood control operation and LRD notified the Tennessee Valley Authority, Nashville District, and the LMRFC at 1242 hours that LRD was assuming direction of Kentucky and Barkley Lakes.

LRN initiated spillway releases at Cordell Hull on Saturday evening at 1730 hours. Through a series of spillway gate operations, at midnight the combined turbine and spillway discharge had reached 60,000 cfs, a target level selected by LRN water managers. This left 12,000 cfs in flow capacity at Carthage to accommodate releases from Center Hill Lake and from the uncontrolled drainage area downstream of both Cordell Hull Dam and Center Hill Dam and upstream of Carthage. Despite this series of spillway gate increases, the Cordell Hull Lake water level had increased from 504.50 at the start of the day to 505.32 at midnight. LRN WM used the flood

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[11] Water Control Manuals (WCMs) provides guidance for managing the water levels and discharges from the Corps water resources projects or system of projects. Examples of a water resources project are a navigation lock and dam or a flood damage reduction project. An example of a system is multiple navigation projects along a river that are dependent on each other's operation and /or with the flood damage reduction projects also along the river or on tributaries that act together to minimize flood damages. Guidance may consist of guidelines, rule curves and operating criteria that govern the storage and release of water from the project. Guidance is developed to meet the objectives and specific provisions of the legislation authorizing the project. Examples of objectives are hydropower generation, flood damage reduction, water supply, recreation, and fish and wildlife. Authority exists to deviate from the water control manual in the event that it is necessary for emergency reasons to protect the safety of the dam and to alleviate other critical situations not foreseen or addressed in the manual.

season discharge of 72,000 cfs (stage 29 feet) at Carthage in lieu of the crop season discharge of 45,000 cfs (stage 20 feet). The 60,000 cfs discharge was held steady in an effort to keep the Cumberland River from reaching flood stage at Carthage and reduce the flows entering Old Hickory.

Saturday morning, LRN WM followed established procedures by staffing the office with an experienced water manager from 0700 hours to 1340 hours. The LRN Water Manager, through coordination with other personnel and the WM Section Chief, implemented a number of measures to respond to changing conditions. Prior to leaving at 1340 hours, the water manager issued a number of instructions to operators at the projects on how to respond to changing water conditions. There were a series of telephonic discussions and coordination made between water management, engineering, projects, and other district personnel throughout the day. Due to rapidly changing conditions at the projects, the LRN WM staff returned at 1900 hours and worked until 2300 hours. There were no direct communications between LRN WM with the NWS OHRFC on Saturday other than the morning reports which are provided by LRD WM to the NWS OHRFC. When the water managers left on Saturday night, the NWS forecast issued at 2118 hours Saturday was for Nashville to crest at 36.2 feet overnight; four feet below flood stage. On Sunday, May 2, the LRN Water Managers returned to work at 0630 hours and began a 24-hour operation that lasted until 2200 hours on Tuesday, May 4. On Sunday, LRN WM, LRD WM, and NWS OHRFC began twice a day conference calls. Kentucky and Barkley Lakes were monitored through the night as TVA River Scheduling normally maintains a 24-hour operation. The NWS issued a 3-Day QPF Sunday morning, Figure 13, indicating an additional 2 inches to 4 inches across the basin. Rainfall prior to Sunday morning ranged from 7 inches to 10 inches across the middle portion of the basin, thus exceeding the predictions of the QPFs on April 29, 30 and May 1 by several inches. By the time the rainfall ended on May 1, a historic rainfall total occurred across much of Tennessee and Kentucky.

Figure 13 – NWS QPF published on May 2, 2010

LRN WM, LRD WM, and NWS OHRFC initiated twice a day conference calls on Sunday. The conference calls occurred at 0830 hours and 1330 hours. At the 0830 hour conference call the current project conditions and the projected rainfall were discussed. The NWS utilized this

information to publish a forecast of a crest at Nashville of 42 feet at 1900 hours on Sunday evening. At approximately 0930 hours on Sunday, LRN lost internet connectivity as a result of a Verizon communication line break in the flood area. The internet connectivity was restored at 2005 hours that evening. The staff did not have an alternate means of connecting to the internet with the exception of a personal cell phone with internet capability. At 1930 hours an "air card" was provided by Army Corps of Engineers – Information Technology (ACE-IT). During the network outage, data from the projects were obtained by telephone directly from the power plant operators. Loss of internet connectivity prevented the LRN WM staff from obtaining data from the stream gages and projects electronically, thus slowing the process to obtain and post data during a time when conditions were changing rapidly. This also prevented the projects, NWS and the public from being able to observe real-time data through their normal methods. The data was available, however, on the rivergages.com website.

Intense storms began around 0700 hours Sunday morning and over the next three hours had added three inches of rainfall on the already saturated ground in the Old Hickory and Nashville area. Overnight, the Old Hickory discharges had been maintained to keep the Cumberland River below the control flow at Nashville; however, by 0600 hours the Old Hickory pool had reached elevation 447.75 and was rising rapidly. Beginning at 1000 hours, a series of spillway gate increases were made at Old Hickory as LRN WM reacted to rapidly rising lake levels. Spillway gate changes were made as often as every 15 minutes to prevent the upstream lock wall from being overtopped. By 1400 hours, Old Hickory reached a new pool of record at elevation 451.45, the surcharge pool storage had been utilized and the lock wall was within 6.6 inches of being overtopped. The analysis of rapidly rising lake levels resulted in water control actions outside of the operations detailed in the project water control manuals to protect Old Hickory Dam from this unprecedented rainfall event. If the lock wall would have been overtopped, the powerhouse would have been flooded.

Prior to reaching this point, the spillway gates would have been pulled out of the water to protect the dam itself and the project would have been abandoned. Pulling the spillway gates out of the water, which would allow the river to free flow, would have resulted in the rapid release of the project's surcharge pool downstream towards Nashville. Thus increasing the river stage accordingly. Preliminary modeling results indicate that if this would have occurred, the stage at Nashville would have been approximately four feet higher at the crest. Despite the numerous spillway gate changes, the pool at Old Hickory exceeded the top of the surcharge pool storage[12] of 450 and ultimately reached a level 1.28 feet higher than it had ever been. During these operations, one spillway gate was out of service for maintenance. This coupled with the magnitude and flashy nature of the storm event required the remaining spillway gate openings to exceed the spillway gate rating tables. This required the LRN WM staff to perform a quick analysis in order to provide the project staff an updated gate rating to cover the additional gate operations. With a total of 19 spillway gate operations, the spillway gates reached a maximum opening of 34 feet at 1700 hours on Sunday. This resulted in a project discharge of 212,260 cfs, which is 46,760 cfs higher than the previous maximum discharge observed during the March

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[12] The purpose of a surcharge pool is to replace the volume of water utilized by the construction of the project. The water control manuals provide guidance to utilize the surcharge pool when a specified stage is reached at a specified control gage. Surcharge pools may be provided for navigation projects. A surcharge pool does not operate the same as a flood damage reduction pool.

1975 event. If LRN WM had taken action to prevent the pool from exceeding elevation 450, the top of the surcharge pool storage, the project would have had even larger releases. These higher flows, when combined with record setting runoff from the local uncontrolled area, would have forced the stage at Nashville to increase more rapidly and sooner than what was observed. This would have further complicated the flood response actions for emergency managers and individuals located downstream of Old Hickory Dam.

When Old Hickory began increasing its discharges at 1000 hours, which increased the flows above the control of 90,000 cfs at Nashville, J. Percy Priest also continued to discharge. The unprecedented rainfall necessitated actions outside the operations in the water control manual; this decision was made, however, in an effort to reserve the remaining storage in J. Percy Priest for control of the flood crest approaching Nashville.

From 1000 hours when the increased discharges were initiated at Old Hickory, until the 1330 hours conference call, LRN WM had no additional communications with the NWS OHRFC. The NWS OHRFC did not have the Old Hickory discharge information when they published another forecast at 1118 hours to state the crest would be 45 feet at 1900 hours. The next update to the NWS OHRFC was provided during the 1330 hours conference call. By this time Old Hickory was above its surcharge pool level and nearing the pool of record. LRN WM intended during the afternoon call to indicate that gate operations were made to pass all inflow to the dam, with the intent of preventing further rises in the Old Hickory pool level. LRN also noted that discharges at this time were above their gate rating curves. LRN assumed that based, on this information, the NWS would run its models as if the project was no longer present. However, the NWS felt that since the Corps was operating the spillway gates, their rated discharges were still reflective of current flow conditions. The NWS OHRFC did not understand the hydraulics of the navigation project operations on the Cumberland River system under the full range of flow conditions. The discrepancies between NWS model outflows and Corps releases were not fully discussed or understood on Sunday as the observed precipitation exceeded the forecast and the river stage approached critical levels in Nashville. The lower projected QPF, coupled with these misunderstandings, affected the accuracy of the NWS OHRFC early forecasts.

Since the 1970s, the information provided to the NWS OHRFC by LRN WM during high flow events had consisted of a plan of operation for the LRN flood control projects (Wolf Creek, Dale Hollow, Center Hill, and J. Percy Priest) and not flow data from the mainstem navigation projects (Cordell Hull, Old Hickory, and Cheatham). The Barkley flows were provided by LRD WM. LRN understood the modeling approach used by the NWS OHRFC was to pass inflow at the mainstem projects where only the surcharge pool storage was available and to route the releases from the flood control projects to develop stage forecasts at the damage centers. That was the data exchange approach employed by LRN WM when the May 2010 flood event began. The LRN senior water managers on duty had employed this same routine since 1984 on a daily basis. There have been 16 high flow events resulting in a Nashville stage greater than 30 feet during this 26 year period where LRN applied this approach. For the May 2010 flood event the NWS OHRFC was expecting more detailed information on releases from the mainstem projects. Once that expectation was realized around 2300 hours late Sunday evening, the updated spillway gate operations were routinely shared with NWS staff. As observed on Figure 14, the NWS forecast accuracy increased.

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In response to the overnight record local inflows and inflows upstream from the Tennessee and Cumberland Rivers, Kentucky and Barkley Lakes pools had risen 4 feet to 363.5 ft from 359.5 ft and were continuing to rise. Both TVA and the Corps recognized that the release schedule would change significantly pending the morning model updates. Following a series of discussions between LRD WM, LRN WM, TVA River Scheduling, and the NWS Lower Mississippi River Forecast Center, LRD developed a water control plan requiring significant increases to the releases from Kentucky Lake and Lake Barkley. Preliminary release increases began at 1000 hours on Sunday while TVA and LRD waited on Cheatham flow estimates from LRN. LRN provided final Cheatham estimates at approximately 1136 hours.

TVA developed a revised flow release schedule at 1400 hours (Table 5). The new schedule increased releases ahead of the Ohio River flood crest then reduced flows during the crest to prevent increasing flood damages on the lower Ohio River. Even with these high releases, the Kentucky and Barkley pools were forecast to continue to climb an additional foot to nearly elevation 365 feet, and then stabilize. This elevation was still significantly above Lake Barkley's Storage Utilization Guide that provides the amount of storage that can be committed to a flood event. This elevation can also trigger dam safety concerns. Reductions in the pool were sought to reduce backwater pressure upstream at Clarksville. The uncertainty in the local[13] and Cheatham inflows to the reservoirs and the rain still to fall in the next 24 hours increased the urgency to stabilize the pool levels in advance of the Nashville flood wave entering Lake Barkley. LRD conducted a teleconference with TVA and LRN to discuss the proposed release schedule. In light of the worsening conditions upstream of Lake Barkley and the record local inflows to both Kentucky Lake and Lake Barkley, the consensus was that the proposed discharges were necessary. Based on the release schedule, daily average discharges of 250,000 cfs out of Kentucky Lake and 230,000 cfs out of Barkley Lake were targeted for May 3. LRD provided the final release schedule to the NWS Lower Mississippi River Forecast Center (LMRFC) at 1430 hours Sunday. LRD also called the OHRFC at 1430 hours to inform them of the high releases at Kentucky Lake and Lake Barkley. The OHRFC requested LRD contact the Paducah WFO directly. LRD contacted the Paducah WFO and as a result they issued a Special Weather Statement warning persons downstream of Kentucky and Barkley Dams to prepare for higher water immediately.

Table 5 - Final Kentucky and Barkley release schedules and pool forecast of May 2.

		May 2	May 3	May 4	May 5	May 6	May 7
Discharge (kcfs)	KY	140	250	270	250	200	150
Discharge (kcfs)	BK	77	230	260	200	100	100
Pool (feet)	KY	364.6	364.6	363.9	363.4	363.8	363.8

[13] **As mentioned earlier, flows from the Harpeth River, Mill Creek, and other tributaries to the Cumberland River were "uncontrolled" due to the lack of water management / dam structures on these waterways.**

At 2100 hours Sunday evening, LRN WM stopped the discharge from J. Percy Priest and the first in a series of spillway gate reductions at Old Hickory occurred in an effort to reduce the flood crest at Nashville. LRN WM took this action based on a projected flood crest at Nashville of 48.0 feet for 0100 hours Monday morning. Again, due to the unprecedented rainfall not contemplated by the water control manuals, the cessation of discharge at J. Percy Priest and the spillway gate reductions at Old Hickory were undertaken by LRN WM to reduce the river crest in Nashville. By midnight, the Old Hickory releases had been reduced from 212,260 cfs to 193,400 cfs.

By 1500 hours on Sunday, Cordell Hull had used only one foot of the surcharge pool storage whereas the water control manual indicated that the full surcharge pool storage should have been used. This was done to conserve the remaining pool for the peak of the event. At 2100, LRN stopped hydropower generation at Center Hill to provide flood control benefits for Carthage, TN, as they expected an increase in discharges from Cordell Hull above the control flow limits. Center Hill returned to operation at 0000 hours on Tuesday, May 4. Given the heavy rainfall that had fallen in the Cordell Hull watershed earlier in the day, it was necessary to make six spillway gate operations, starting at 2200 hours and continuing overnight. This was to prevent the upstream lock gate from being overtopped. The gate changes occurred as often as every thirty minutes and continued until 0500 hours on Monday morning when a new pool of record was reached at elevation 508.33 and a discharge of 130,100 cfs. Increasing the spillway gate operations at a more frequent rate than the guidance in the water control manual was necessary to maintain control of the structure and avoid higher discharges later, which would have increased the impacts downstream. At this time, the Cordell Hull pool was only 2 inches from overtopping the upstream lock gate. If water had reached the point of flowing over the lock gate it would have resulted in an uncontrolled project release and would have resulted in larger flows reaching Carthage and points downstream. The discharge was held constant and the pool fell to elevation 507.80 at approximately 1100 hours, then LRN initiated spillway gate reductions.

LRN stopped hydropower generation at Dale Hollow and Wolf Creek at 2300 hours and 2400 hours, Sunday evening, respectively. LRN took these actions to reduce flows downstream during the crest. Dale Hollow and Wolf Creek resumed hydropower generation Monday, 1500 hours, and Tuesday, 0000 hours, respectively.

Spillway gate reductions at Old Hickory continued early Monday, May 3. However, when the increased discharges from Cordell Hull and the local inflow from the uncontrolled portion of the Old Hickory watershed reached Old Hickory Dam, the lake level increased to elevation 451.25 by 0300 hours. Thus, Old Hickory spillway gate increases were again necessary and the discharges increased to 197,000 cfs by 0615 hours. LRN maintained this discharge rate until 1300 hours, when the spillway reductions resumed. This action recovered a small volume of storage at Old Hickory that could be applied later when the crest approached Nashville.

Celina gage posted a flood crest of 37.62 feet at 0600 hours, Monday morning.

With the pool at elevation 502.0, J. Percy Priest resumed hydropower generation at 0715 hours to prevent overtopping of the spillway gates, which would have occurred if the pool reached elevation 504.5.

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By Monday morning, May 3, the rainfall totals reached 15 to 18 inches in some areas and were greater than 10 inches over a widespread area of the lower Cumberland River and Kentucky Lake. The totals exceeded the scale of the map published daily by the National Weather Service. The 13.56 inches recorded at Nashville was twice that of the prior record of 6.68 inches in 1979 from Hurricane Frederick. The high rainfall occurring directly on and around Kentucky and Barkley Lakes and the upstream inflow from Nashville continued to raise Kentucky and Barkley Lakes despite the rapidly increasing discharge rate. The lakes rose overnight to 365.05 feet and continued to rise.

Early Monday, May 3 (0600 hours), the release from Kentucky Lake was 252,000 cfs and the release for Lake Barkley was 219,000 cfs. TVA now recommended releases as high as 300,000 cfs to stabilize the pool levels prior to the Nashville peak flood wave reaching the Barkley pool, as they recognized the uncertainty of the flow Lake Barkley would receive. LRN expected Cheatham to have a peak flow of 350,000 cfs at approximately 1800 hours.

In order to provide sufficient storage for the increased flows coming from Nashville, TVA and LRD coordinated a discharge increase to 300,000 cfs for Lake Barkley and 340,000 cfs for Kentucky Lake (see Table 6). LRD WM shared these updated discharge figures during the Emergency Operations Center Brief (0900 hours) with the LRL EM and State of Kentucky Emergency Management. LRD WM discussed the lakes management strategy, preliminary pool and release schedules and the Ohio River forecast at Smithland Lock and Dam tailwater, Paducah and Cairo, IL. This same forum discussed the Barkley tailwater forecast and determined it had the potential to rise to elevation 348 feet as the LRD Ohio River model had predicted. Barkley tailwater was at elevation 340.3 feet at 0600 hours. Concern grew about the pending impacts to the town of Smithland due to rising Ohio River stages and Lake Barkley releases. The NWS Paducah WFO issued another Special Weather Statement warning of the increasing releases from Kentucky and Barkley Lakes and of their rising pools due to record flooding. The NWS warned persons downstream of the dams to prepare for sharp increases in water levels and that the tailwaters below the dams were expected to reach elevation 335 feet at Kentucky and elevation 350 feet at Barkley. The statement also warned of rises on the Ohio River. NWS followed the Special Weather Statement with a Flash Flood Warning for Crittenden County.

The Barkley water control manual does not address notification of downstream communities when significant flow increases are made. The practice has always been that LRN WM contacts the Barkley power plant operator and issues instructions on how and when spillway gate changes are to be made. In turn, the operator alerts both Barkley Lock and Lock & Dam (L&D) 52 of the upcoming change. Historically, the Barkley Resource Manager's Office typically coordinates with local emergency management offices on flow increases; however, this procedure is not a formalized process. Due to the rapidly changing conditions facing LRN WM, the Resource Manager did not obtain notification of the Barkley increases in a timely manner to alert the downstream emergency managers. However, the NWS provides Special Weather Statements and Flash Flood Warnings to the local emergency management agencies.

The increased discharges resulted in tailwaters increases that in turn flooded several low lying residences downstream of the dams. The Kentucky and Barkley Water Control Manuals do not address downstream impacts immediately below the dam; but as noted in Section 3, these projects are not operated for flood control immediately below the dams. A post-flood analysis

DRAFT

showed that if the high releases had not been made from both projects, Barkley Lake may have reached as high as elevation 380 feet, 5 feet above the maximum flood control pool.

Table 6 - Noon Kentucky and Barkley release schedules and pool forecast of May 3.

		May 3	May 4	May 5	May 6	May 7	May 8	May 9
Discharge (kcfs)	KY	295	340	288	168	100	100	100
Discharge (kcfs)	BK	262	300	258	182	150	150	150
Pool (feet)	KY	364.4	364.4	365.0	366.9	368.2	368.6	369.1

When Cordell Hull began spillway gate reductions at 1100 hours, Monday, they were able to reduce the flows at Carthage, TN, located a short distance downstream of Cordell Hull Dam. LRN WM issued instructions to the Cordell Hull operators to continue making spillway gate reductions as long as possible without making the pool level increase above elevation 508.0. Operators made eleven spillway gate changes between 1100 hours and 2300 hours as the project inflows continued to decrease throughout the day.

A flood crest of 46.06 feet occurred at the Carthage gage at 1200 hours, Monday.

LRN WM initiated a new series of spillway reductions at Old Hickory at 1300 hours, Monday, to reduce the flood crest at Nashville with emphasis placed on preventing inundation of Nashville's Omohundro Water Treatment Plant. This was critical since Nashville's other water treatment plant (K. R. Harrington located at the mouth of the Stones River) had been flooded earlier in the day. Thanks to intensive sand bagging efforts using LRN EM-furnished sand bags, the City of Nashville protected the Omohundro Water Treatment Plant and ensured it was able to provide treated water to its customers. By a series of six spillway gate reductions the discharges from Old Hickory had been reduced from 196,500 cfs to 144,200 cfs by 1900 hours. The Old Hickory lake level was closely monitored by field and water management personnel during these flow reductions. LRN allowed the pool to rise back above the top of the surcharge pool storage. Although a deviation from the Old Hickory Water Control Manual, these actions prevented additional water from contributing to the crest as it entered the Nashville area. A break in weather conditions provided this opportunity. The rain ceased and significant flow reductions occurred at the upstream projects as the flood crest had already passed. Old Hickory required no additional spillway gate changes until Wednesday, May 5.

TVA made a special request, 1500 hours, Monday, to address a power transmission line problem associated with the Dale Hollow hydropower facilities being off-line. This required bringing one hydropower unit back on line. LRN WM evaluated the situation and determined that since the river at Celina had crested and local flows were receding, that one unit would meet the requirement and was brought back on line without any downstream impacts.

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The Nashville gage crested at 1800 hours on Monday, May 3. Figure 14 portrays the Nashville gage river stages. The figure illustrates NWS forecasts, Nashville rainfall and several significant Corps project activities.

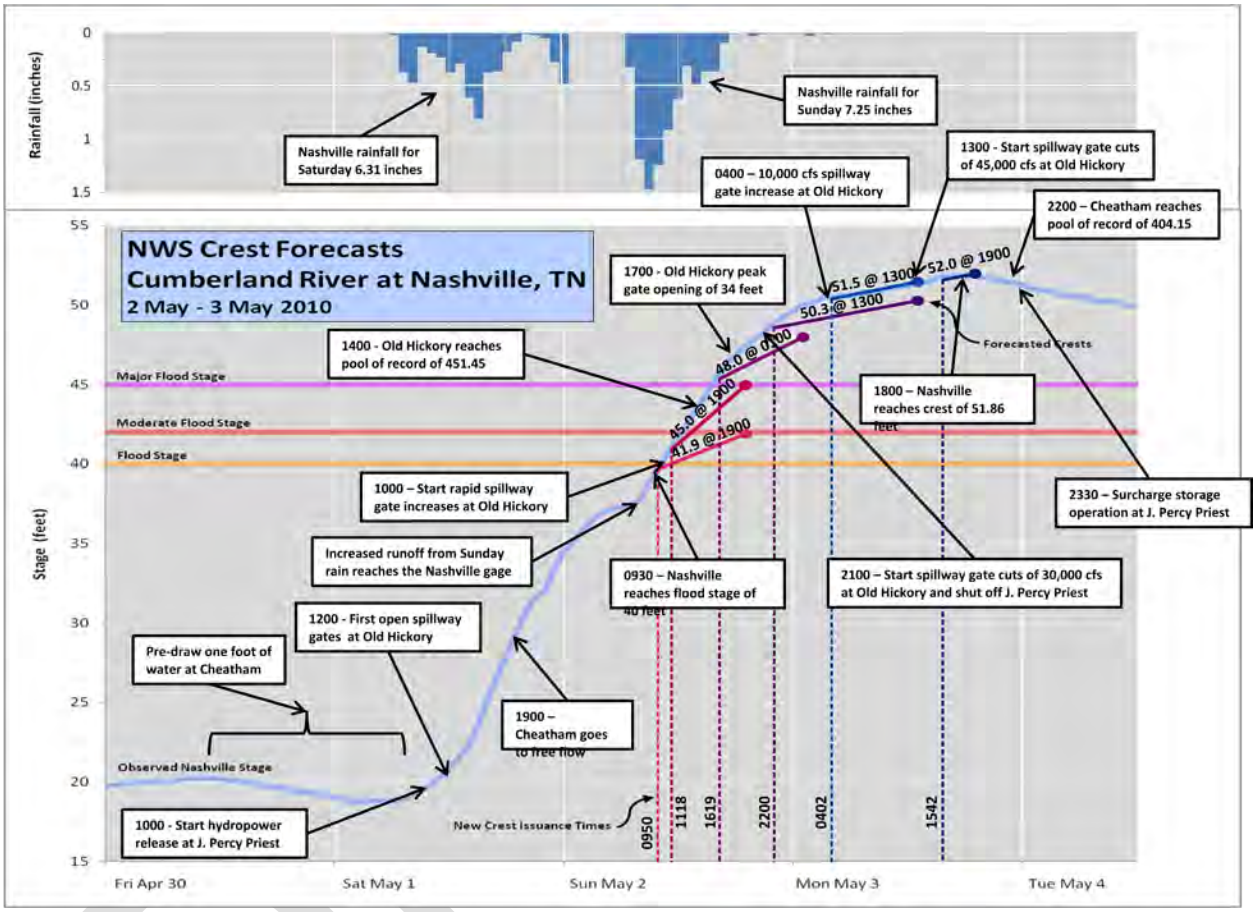

Figure 14 – River stages at the Nashville gage and the National Weather Service forecasts.

LRD EOC notified LRD WM at approximately1700 hours of requests by the town of Iuka, KY, (downstream of Barkley Dam) for flood relief. LRD, TVA and LRN WM revisited the Kentucky and Barkley release schedule. The Dam Safety Officer, in consultation with LRD WM, decided to reduce flows out of Kentucky Lake and Lake Barkley by 20,000 cfs and 40,000 cfs, respectively. However, gate submergence issues[14] limited the Barkley reduction to 20,000

[14] **When the Barkley project experiences extremely high tailwater elevations a submergence problem may be encountered with operation of the spillway gates. The Barkley spillway gates must be clear of the water on the tailwater side when in operation or they will be subject to extreme vibration. Therefore, a gate must be either closed or open high enough to clear the tailwater. As a result, operators and water managers are sometimes unable to produce the desired flow and must decide on either a flow lower than the target or higher. The differences can be fairly significant since extremely large gate openings are required at the individual gates.**

cfs. Operators made two spillway gate reductions to reduce the Lake Barkley outflow to approximately 280,000 cfs at 1900 hours.

At 2200 hours on Monday, Cheatham reached a new pool of record of elevation 404.15.

To prevent the Nashville stage from going any higher, LRN dispatched Old Hickory hydropower personnel to J. Percy Priest Dam Monday evening to carry out a surcharge storage operation. These personnel were to continuously track the J. Percy Priest lake elevation, and when the pool reached the top of gates, were to open each gate to a gate opening of 0.5 foot. However, one of the four spillway gates did not function properly. The field staff opened one gate to 1.0 foot and two gates to 0.5 ft. An Old Hickory power plant electrician quickly diagnosed the problem and made the necessary repair. This expeditious action prevented the non-functioning gate from being overtopped. Old Hickory personnel opened all four spillway gates at 2400 hours 0.5 feet. This resulted in a project release of 7,000 cfs rather than the 17,000 cfs required by the water control manual. For the period starting Monday, evening, May 3, and extending through the middle of the day on Wednesday, May 5, the combination of water control actions executed by the LRN Water Managers at these two projects resulted in significant stage reductions (~ 2 feet for much of this period) at Nashville.

On Tuesday, May 4 at 0000 hours LRN performed operations in accordance with the Water Control Manuals as two hydropower units at Wolf Creek and one hydropower unit at Center Hill were brought back on line. A third hydropower unit was brought on line at Wolf Creek at 1200 hours.

LRN initiated a series of spillway gate reductions between 0000 hours and 0500 hours to reach control flow discharge of 72,000 cfs (stage 29 feet), as the local runoff at Cordell Hull receded. LRN held this flow until 1600 hours and then developed a plan to transition to normal operating levels. By 0600 hours on Wednesday, LRN closed all spillway gates at Cordell Hull and the project returned to normal operation.

Between 0400 hours and 1600 hours on Tuesday, submergence problems occurred with the spillway gates at Barkley Lock and Dam. The submergence problems required the Barkley power plant operators to make a series of gate changes between 0500 hours and 0805 hours. The final result was an outflow higher than the target during this period and Barkley set a new discharge record of 303,200 cfs at 0800 hours. At this time LRN WM advised Barkley to reduce the project discharge to 240,000 cfs. Again, due to the submergence problems the operators could only achieve 266,000 cfs by completely closing one gate. LRN WM then advised Barkley to close one additional spillway gate. This resulted in a project discharge of 230,000 cfs, the target discharge directed by LRD WM.

A flood crest of 62.58 feet occurred at the Clarksville gage at 0700 hours, Tuesday. A surcharge operation at J. Percy Priest began at 2330 hours the previous day. By 0800 hours, Tuesday, the lake level had risen to the point that a gate adjustment was required to prevent overtopping the gates. The operators raised the gates an additional 0.3 foot each to prevent water from overtopping the gates. This increased the project release from 7,000 cfs to 8,600 cfs. These

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actions did not add to the flooding downstream since the flows from the uncontrolled portions of the basin were now receding.

LRN initiated a series of spillway gate reductions at Old Hickory on Wednesday, 0900 hours. Ten spillway gate reductions occurred on Wednesday. These spillway gate reductions continued on Thursday and by day's end Old Hickory operating within its normal range.

At 1200 hours, Wednesday, LRN brought two additional hydropower units at Wolf Creek, one additional unit at Dale Hollow, and one additional unit at Center Hill on line. Center Hill brought a the third hydropower unit on line at 1400 hours.

Adjustments to project releases to evacuate water from storage continued on Thursday at 1000 hours as Wolf Creek opened two sluice gates. At 1230 hours Center Hill opened two sluice gates. Barkley initiated a series of spillway gate reductions at 1000 hours to reach a total flow of 150,000 cfs by 1900 hours to support ongoing flood control operations for the lower Ohio River.

On Friday, May 7, no significant water management actions were necessary. Cordell Hull and Old Hickory had returned to normal operating levels; Wolf Creek, Dale Hollow, Center Hill, and J. Percy Priest continued evacuating water from storage to reach the normal pool levels. Cheatham remained in free flow as it had been since Saturday, May 1, and Barkley reached a peak pool for this event at elevation 369.00. This elevation is approximately 1.0 foot lower than a pool of record established during the May 1984 flood event.

Operators placed the Cheatham spillway gates back in service at 0830 hours, Saturday, returning the project to normal operation. Operators continued evacuating the water from storage at J. Percy Priest and Barkley.

Figures 15 through 19 provide project operation summaries and include downstream control gage information.

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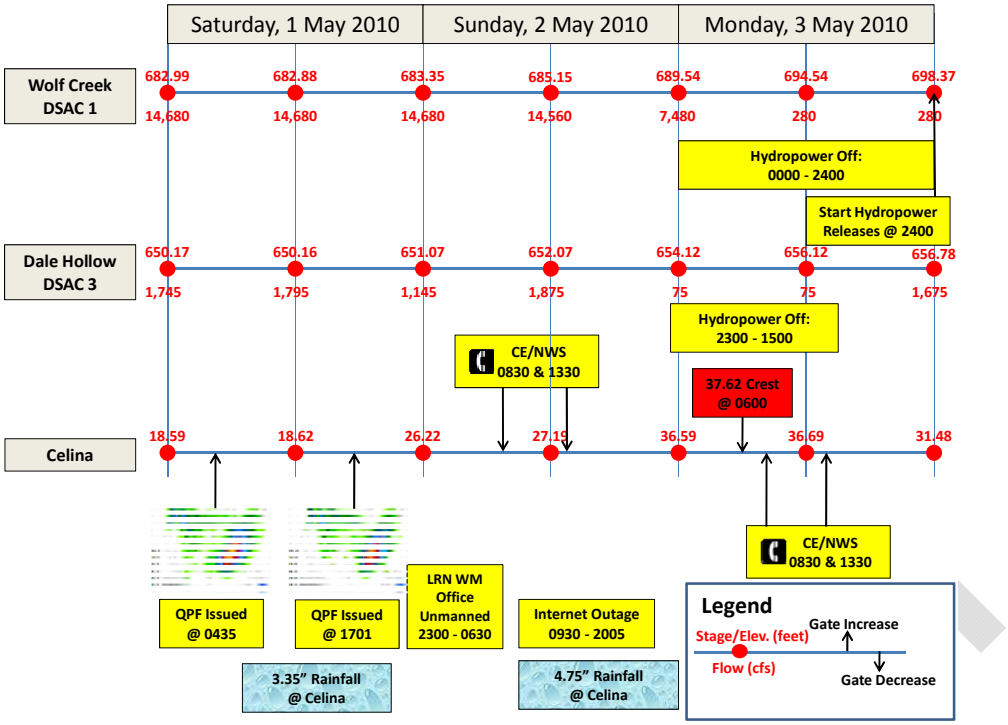

Figure 15 – Wolf Creek, Dale Hollow and the Celina gage.

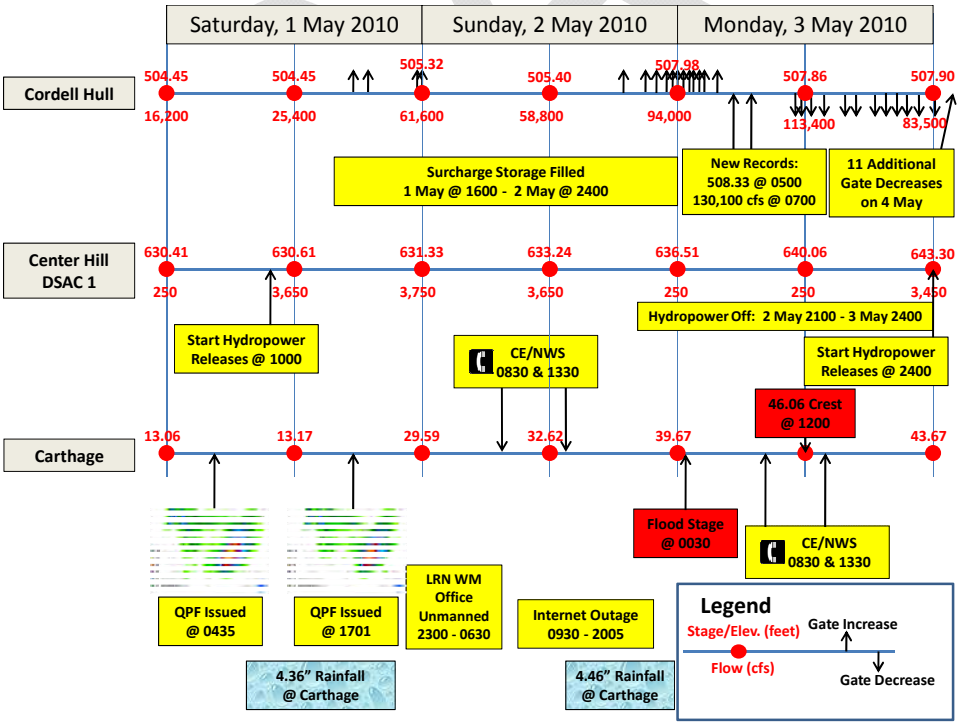

Figure 16 – Cordell Hull, Center Hill and the Carthage gage.

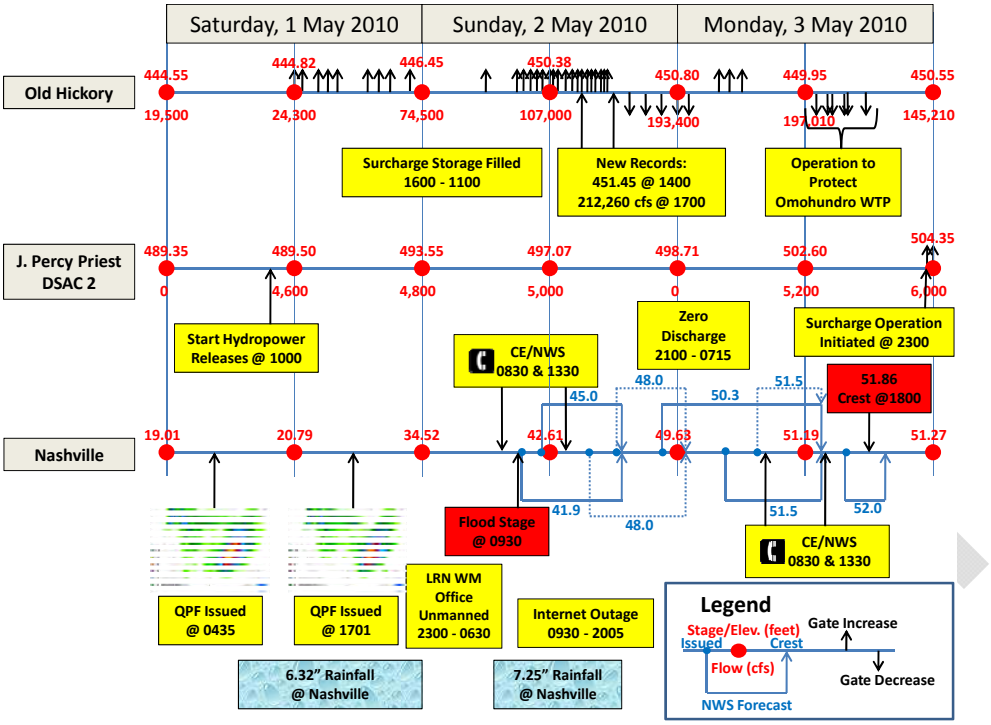

Figure 17 – Old Hickory, J. Percy Priest and Nashville gage.

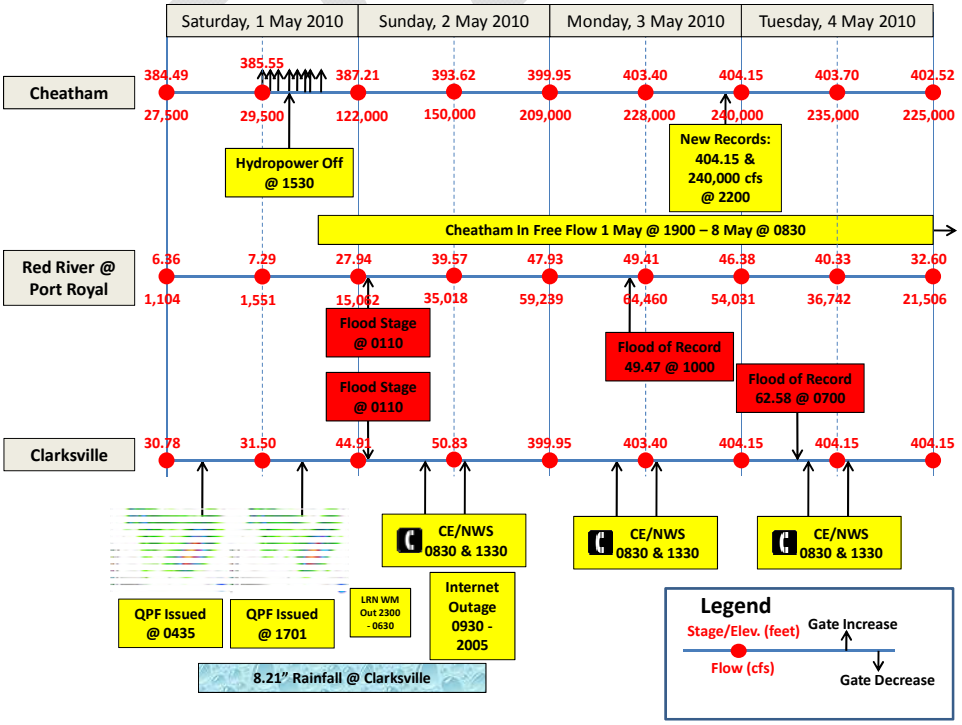

Figure 18 – Cheatham, the Red River at Port Royal gage and the Clarksville gage.

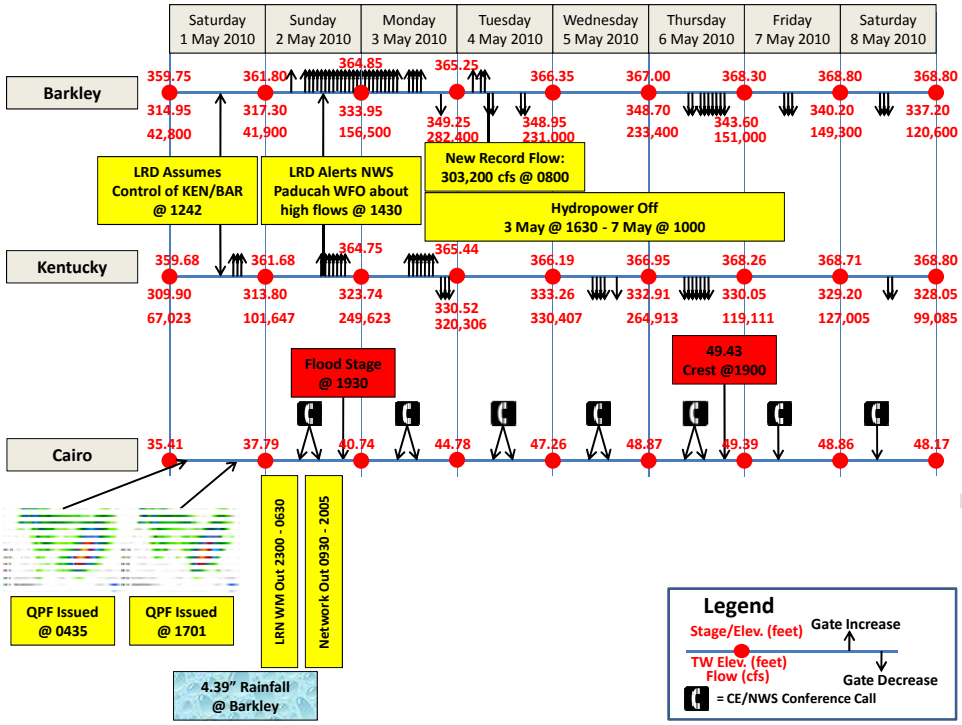

Figure 19 – Barkley, Kentucky and the Cairo gage.

5.2 Summary of Corps Dam Safety Actions

The Nashville District has 10 multipurpose dams on the Cumberland River and its tributaries. Nationwide, the Corps evaluated each of its dams and classified them in the Dam Safety Action Classification (DSAC). Wolf Creek and Center Hill dams are classified as DSAC I[15] dams, J. Percy Priest is a DSAC II[16] dam, Barkley Lock and Dam, Dale Hollow, Old Hickory Lock and Dam, and Cordell Hull Lock and Dam are DSAC III[17] dams. Each of these projects has an

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[15] DSAC I classified dams are unsafe and are urgent and compelling because they have confirmed dam safety issues that require immediate actions to reduce the risk of catastrophic dam failure. The DSAC rating is characterized by a dam being critically near failure under normal operations and certain to fail if actions are not taken immediately or within a short time frame to correct the unsafe condition. A Corp Dam can be classified as DSAC I also because of extremely high risk from a combination of life or economic consequences when the probability of failure is extremely high.

[16] DSAC II classified dams are unsafe or potentially unsafe and are urgent because they have confirmed or unconfirmed dam safety issues in which dam failure initiation is foreseen and therefore require actions to reduce the potential for failure. The failure could begin during normal operations or could be initiated from a triggering event. The likelihood of failure from one of these occurrences, prior to remediation of the dam, is considered very high and the combination of life or economic consequences is too high to assure public safety without steps taken to reduce the risk.

[17] DSAC III classified dams are conditionally unsafe and are high priority because they have confirmed or unconfirmed dam safety issues or the combination of life or economic consequences with the likelihood of failure is moderate to high. These dams require interim measures to reduce the dam safety risk until long-term remediation of the dam can be completed.

approved Interim Risk Reduction Measure (IRRM) Plan that calls for increased monitoring during flood events or as identified by the project engineers.

Wolf Creek and Center Hill Dams are undergoing rehabilitation to correct foundation seepage problems and have lowered interim pool operating levels to reduce pressure on the dam foundation. Wolf Creek reached its maximum pool elevation 703.86 during the recent flood at 2400 hours on May 6. Center Hill rose to elevation 646.76 on May 5 at 1400 hours. Wolf Creek and Center Hill flood operations did not place either dam at risk for failure. Both projects had been operated with similar pool levels within the previous year with no dam safety concerns. The Wolf Creek pool reached elevation 701.63 just a few months earlier (2/10/2010) during a high flow event. Likewise, Center Hill experienced higher lake levels last May (5/11/2010) when the pool reached elevation 650.37, four feet higher than the May 2010 event. Going into the flood, Wolf Creek was operating four hydropower turbines (14,560 cfs) around the clock in an effort to return the lake level to the IRRM plan following heavy rain the week before. The flood operation that LRN implemented at midnight on May 2 involved stopping all use of the hydropower turbines for a 24-hour period; however, 280 cfs was flowing from the fish hatchery and one low flow orifice gate. This action eased concerns of overtopping the lock gates at Cordell Hull Dam. Once the uncontrolled inflow to Cordell Hull and the accompanying flood risk diminished, Wolf Creek gradually increased releases by bringing the hydropower units back on-line to reduce the storage/pool level. Wolf Creek and Center Hill had extensive foundation treatment completed in this past year along with extensive instrumentation and automated real time instrumentation readings that indicate any issues of possible distress in the dam and foundation. The potential for exceeding the interim operating levels at Wolf Creek and Center Hill on a short duration/temporary basis during floods have been factored into the projects risk analysis and do not place the dams at risk.

J. Percy Priest Dam operated in a manner to reduce the impacts of releases from the project as the flood crest moved down the Cumberland River, which resulted in the lake level exceeding the top of spillway gate elevation of 504.5. The surcharge operation on Monday, which took the lake level to elevation 504.9, prevented overflow of the spillway gates and a resulting uncontrolled release to the Stones River. When the flood crest passed and the local runoff subsided to the point that J. Percy Priest releases could increase, the flood storage was recovered through a planned spillway and hydropower release pattern. These water management operations did not impose any dam safety threat to either the structure or the outlet works. Daily visual inspections and evaluation of piezometer readings did not indicate dam safety concerns for the project.

Barkley Lock and Dam had a historical maximum discharge of 303,200 cfs. During the flood event, the project was visually inspected twice daily. The project engineers reviewed the embankment piezometers from the twice a day readings. There were no indications of a dam safety concern during this event for Barkley. The twice a day visual inspections and piezometer readings at Dale Hollow Dam indicate that the project performed well with no dam safety concerns.

Old Hickory Lock and Dam experienced a tremendous water load coming within 6.6 inches of overtopping the lock gates. A maximum historical discharge of 212,260 cfs along with a historical maximum headwater elevation of 451.45 feet was set during this event. During this event, the field staff visually inspected the project and made embankment piezometers readings.

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The project suffered some minor operational damage but performed well and there were no dam safety concerns noted. Old Hickory spillway gate operations utilized the surcharge pool storage to maintain control of flow through the dam and to prevent uncontrolled overtopping of the lock walls (elevation 452.0) and flooding of the powerhouse. It is important to note that the embankment section of the dam is elevation 455.0. Overtopping of the lock walls and the embankment section could lead to erosion and failure of the dam. If the pool would have overtopped the lock walls, the spillway gates would have been inoperable, resulting in uncontrolled flow and increased downstream impacts.

Heavy rainfall fell early on May 2 in the Cordell Hull watershed requiring six spillway gate operations starting at 2200 hours and continuing overnight, to prevent the upstream lock gate from being overtopped. Spillway gate changes occurred as often as every thirty minutes and continued until 0500 hours on Monday morning when a new pool of record occurred at elevation 508.33 and a discharge of 130,100 cfs. The pool at Cordell Hull pool was only 2 inches from overtopping the upstream lock gate. If water had reached the point of flowing over the lock gate it would have resulted in an uncontrolled project release and would have resulted in larger flows reaching Carthage and points downstream. Field staff continued to visually inspect the project throughout the flood event. The turbulent water in the downstream area affected some areas of riprap, but no dam safety concerns occurred during the event.

Cheatham Lock and Dam experienced the most impact. It experienced a maximum historical discharge of 240,000 cfs along with a maximum historical headwater elevation of 404.15 feet. The project is designed to be overtopped during major flood events due to its lack of storage capability. Major electrical issues at the lock resulted from the project overtopping, but post-inundation inspections identified no dam safety concerns. The other District projects, Laurel Dam and Martins Fork Dam, experienced significantly less rainfall during this event, performed well, and no indication of dam safety concerns were noted.

LRN continues to monitor the projects closely. Nashville project staff and District office personnel will continue with thorough evaluation of all Nashville District Dam projects.LRN project and District office personnel are continuing to monitor the projects and evaluate them as the periodic inspections occur.

5.3 Coordination with National Weather Service

For the Cumberland River Basin, the Corps works with the Ohio River Forecast Center (OHRFC), the Lower Mississippi Forecast Center (LMRFC), the Nashville Weather Forecast Office (NWFO), and the Paducah Weather Forecast Office (PWFO). Each day LRD WM provides the NWS OHRFC a morning report that contains the reservoir release data and forecast for the seven LRD District reservoirs. The NWS applies this information to account for the operation of the Corps dams in its hydrological forecasts. During flood events, the communication between both agencies increases. LRD works closely with the LMRFC in producing the public forecasts for the lower Ohio and Mississippi Rivers. Appendix D, Corps Timeline of Events and Appendix E, National Weather Service (OHRFC and NWFO) Timeline of Events provides information as to the time and basic content of the communication that occurred.

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LRD WM initiated conference calls between LRD, LRN, TVA, and NWS LMRFC, on Saturday, May 1 as per lower Ohio-Mississippi River flood control protocol. As part of this protocol, LRD WM coordinates with TVA, and then contacts LRN WM to exchange data. LRD then passes forecasted release information to the NWS LMRFC for Kentucky and Barkley Lakes. On Sunday, May 2, LRD held two additional conference calls at 0830 hours and 1330 hours to communicate the rapidly changing Cumberland System operations to the NWS OHRFC that included LRN WM. The NWS OHRFC received the LRD morning report on Saturday morning; however, NWS OHRFC did not obtain any additional project data that day. The NWS OHRFC attempted to contact LRN WM late Saturday evening and early Sunday morning. They did not reach anyone in the office nor did they leave any messages.[18] LRN Water Managers were at the District office until 2300 hours, returning Sunday at 0630 hours and began 24-hour operations until 2200 hours Tuesday (May 4) evening.. The NWS OHRFC did not attempt to contact LRD WM for assistance in reaching LRN until Sunday morning. As noted, twice daily conference calls occurred at 0830 hours and 1330 hours, beginning Sunday morning. Additional telephone conversations took place late Sunday evening and early Monday morning. On Sunday, between conference calls, additional releases from the projects occurred and this information was not provided to the NWS except during the scheduled conference calls. LRN increased the frequency of calls late Sunday evening. Coordination with the NWS is one area where the Corps believes improvements can and should occur. This is further discussed in Section 6.5.2, OHRFC/WFO Communication and Appendix H, Lessons Learned.

Refer to Appendix E for the timeline for the National Weather Service (NWS) Ohio River Forecast Center.

5.4 Coordination with United States Geological Survey

During this flood event, the resources of the United States Geological Survey (USGS) were under-utilized by the Corps and the National Weather Service. USGS personnel from the Kentucky and Tennessee Division of Water Science Centers were in the field taking flood measurements, setting high water marks and taking stream flow measurements. With personnel in the field it had the opportunity to provide real-time observations to both agencies if requested. Also if needed it could have determined if any damaged gages could be quickly repaired or temporary gages installed to provide data. Its services were not exploited during this event, which is another area of improvement for future events.

The Corps and the USGS jointly participate in the Cooperative Gaging program mentioned in Section 3.3. In May 2005, however, LRN contracted with a private entity to perform gage maintenance in combination with its in-house staff. The contract has now expired and LRN is developing a stream gage transition plan that that will lead to increased coordination with the USGS and will applythe strengths of the participating agencies.

[18] **LRN Water Management initiated 24-hour operations at 0630 hours on Sunday, May 2 and continued until approximately 2200 hours Tuesday, May 4.**

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5.5 Coordination with Tennessee Valley Authority

Section 3.4 discusses the responsibilities of the Tennessee Valley Authority (TVA). During flooding on the lower Ohio and Mississippi Rivers, TVA is directed to regulate the release of waters from the Tennessee River into the Ohio River in accordance with such instructions as LRD WM may be issued. During this flood event, LRD WM initiated coordination with TVA on Saturday, May 1. At that time and continuing through the event, LRD and TVA coordinated the releases of Kentucky Lake and Lake Barkley. The Summary of Corps Water Management Operations in Section 5.1 discusses these coordination activities.

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6.0 LESSONS LEARNED SUMMARY

After Action Reviews (AAR) provide performance-oriented evaluation and feedback used to identify successes and shortcomings. The review of an event allows the team to discover issues by addressing each of the following questions:

- What was planned?
- What actually happened?
- Why did it happen?
- How can we do it better?

The resulting issues provide candid insights into specific individual, team, and organizational strengths and weaknesses from varying perspectives, and feedback and insight critical to learning. These lessons (presented as "issues) are intended to foster professional development for individuals, team, and organization learning and improved future performance.

LRD Conducted two AAR sessions to discuss flood event activities. The first occurred on May 18 & 19, between the Corps elements involved in the event from the Great Lakes and Ohio River Division (LRD), Nashville District (LRN) and Louisville District (LRL). Representatives from the Huntington District (LRH) and Pittsburgh District (LRP) also participated to facilitate and provide observations to help identify topics to be included in the lessons learned. A second session took place on June 2, between these Corps Division and District Offices and representatives from the National Weather Service (NWS) Ohio River Forecast Center (OHRFC), Nashville Weather Forecast Office (WFO), Kentucky and Tennessee United States Geological Survey (USGS) Water Service Centers, and the Tennessee Emergency Management Agency (TEMA). After the completion of these sessions, follow-up discussions occurred to insure that the issues were understood, and in some cases, brought additional issues to light. The Corps Logistics Activity (ULA) also conducted an After Action Review session with its involved elements. In total, the review identified twenty-seven issues spanning three major topic areas: communication, emergency management and water management.

Appendix H, Lessons Learned, addresses the details for each issue, addressing the questions asked. This section provides a brief summary of those issues.

6.1 Communication

6.1.1 External Communication

Issue 1 discusses improving integration with USGS. During the flood event the Kentucky and Tennessee USGS Water Science Centers deployed personnel the field to take flow measurements at key locations, improve stage-discharge rating curves and repair equipment. The Corps and the NWS did not utilize the USGS field personnel available to provide real-time observations. In the future, the Corps and NWS will provide the USGS a listing of critical gages and flood stages and major flood levels to the USGS so they will have those items to address during a future flood

DRAFT

event. Additional efforts to increase communication between the agencies will occur by participating in annual meetings and participation in routine interagency conference calls during a flood event.

Issue 4 discusses methods of improving risk communication. During the flood event, LRN received numerous telephone calls requesting information on the areas being flooded. The public voiced concerns about how the Corps projects were releasing water and increasing the flood levels downstream as a result. The NWS has the responsibility to provide flood forecasts to the public. Its forecast format references a stage at a location on the river; however, the general public cannot correlate how this stage information may relate to where they live. In the short term the NWS is evaluating additional features that could be added to its forecasts that better describe the area related to a flood stage. For the long term, the Corps, NWS and USGS are evaluating an initiative under the Integrated Water Resources Science and Services (IWRSS) project that would provide inundation maps for different river flood stages that would be available to the public.

A common public misconception is that all navigation projects hold back floodwaters just like flood control projects. Some of the navigation projects have a flood surcharge pool, the purpose of which is to replace the volume of water utilized by the construction of the project. We recognize the requirement to improve public awareness of this information.

6.1.2 Internal Communication

Issue 2 discusses means of improving internal communication before and during potential flood events within the Corps Lakes and Rivers Division. During this flood event, an advance email from LRD WM regarding increases in the flood forecast did not receive immediate attention by LRD staff, resulting in slower communication regarding the potential severity of the flood. In order to prevent this from occurring in the future, the Deputy District Commander will develop a trigger for convening an emergency meeting of key staff for a trigger for significant events.

Issue 3 addresses providing redundant communication between the District office and project personnel. When internet connectivity was lost on Sunday due to a Verizon line break, all automated data exchange between the project personnel, field equipment and LRN WM was performed manually by telephone. This impaired the ability of the water management personnel to quickly analyze and respond to changing conditions. LRN WM will build redundancy in the reporting of project data. LRN is currently obtaining air cards, laptops and satellite phones necessary for Water Management and project offices.

Issue 5 discusses improving the process to recall District personnel to provide assistance during the event. Since the event occurred on a weekend, combined with major flooding in the area, minimal staff was on hand to provide assistance, such as answering phones. The flood directly impacted staff members were directly who experienced great obstacles in travel around the city. As a result, the available staff divided their time between regular duties and answering public inquiries. LRN will evaluate, update and revise their recall processes and system.

DRAFT

6.2 Emergency Management

6.2.1 Emergency Operations Center

Issue 6 addresses sustaining communications between LRN EM and TEMA. The EOC personnel felt they would be more effective if they had a data sheet from subject matter experts so that they could speak accurately about relevant topics. Topics might include the basics of how to address a sand boil on a levee. The EOC personnel do not seek to be subject matter experts themselves, but seek a greater familiarity in order to contribute to ongoing actions. LRN will develop procedures for creating such information tools.

Issue 7 discusses sustaining Emergency Management Operations during a flood event. LRN placed an Emergency Management Liaison in the state emergency management operations office (TEMA). In the future, an improvement will be to augment the liaison with the appropriate subject matter expert from the district (or externally augmented) who is well versed in the type of event occurring.

The efficient use of ENGLink[19] is discussed in Issue 8. The EOC specialist needed appropriate permissions and additional training to be more effective in the use of this Corps Emergency Operations System. LRD will provide the training so EOC personnel can perform their duties more efficiently.

Issues 9, 10 and 11 discuss sustaining pre-event coordination (internal coordination between the potentially impacted Divisions and Districts), response phase actions (support provided to the state and FEMA) and recovery phase (completion of FEMA mission assignments) of emergency operations. LRD, LRN and LRL Emergency Managers captured proven business practices and procedures for each phase. This is an area to sustain for future events.

6.2.2 Logistics – Corps Logistics Activity (ULA)

Issue 12 discusses improving the logistics response to allow for proper situational awareness and facilitate rapid planning for the response effort. The combination of the Corps Logistics Activity (ULA) Logistics Activity Center (LAC) displacement without communications due to floodwaters at the Naval Air Station, Millington, TN, and the rapidly evolving events in the Nashville area hindered the transfer of information and guidance to properly plan the support effort. LRD Logistics Management will develop a logistics battle rhythm early in every operation that outlines all communication and reporting requirements. For any event, the assigned ULA personnel will establish and maintain clear and effective communications from the onset. LRD Logistics filled this leadership void and provided necessary guidance and priorities.

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[19] ENGlink is the software program use by USACE to manage information, execution and personnel in response to an event. It also contains a database of all Corps personnel to document physical status, training and essential personnel data.

DRAFT

Issue 13 discusses improving the continuity of operations for the ULA. The ULA Continuity of Operations Plan (COOP) was not finalized prior to the event and key participants did not know their roles in the event of ULA COOP execution. ULA will finalize its COOP and ensure every node in the ULA understand their respective roles.

Issue 14 addresses improvement of the LRN Logistics Delivery Point (LDP) 24-36 hour support plan. Although LRN LDP staff effectively executed their support plan, this event showed the criticality of having an updated 24-36 hour plan and battle book to facilitate support during the early phases of a no-notice event. LRN Logistics Management will update their plan and battle book based on lessons learned from this event.

Issue 15 covers resourcing of the Logistics Planning and Response Team Members. During this event the team members had neither cell phones nor laptops with internet connection capability. ULA is pursuing development and procurement of "fly-away" kits containing the required equipment.

Issue 16 discusses improving logistics personnel ability to use ENGLink. Not all logistics support members were familiar and proficient in the logistics and deployment module sections of ENGLink utilized by the EOC. The ULA will add the ENGLink Logistics / Deployment Module training to their Master Training Plan.

Issue 17 discusses developing duty descriptions for logistics team members. The ENGLink system allows for requesting an individual with specific skill sets that are differentiated by the duty description; however, has not finalized all applicable logistics duty descriptions. ULA Logistics, Planning and Operations Division will create these duty descriptions for each applicable position ENGLink.

6.3 Water Management

6.3.1 Infrastructure Maintenance

Issue 18 addresses improving awareness of project maintenance status. During the event, an unscheduled outage of a turbine and scheduled maintenance for a spillway gate prevented their usage at Old Hickory Dam. At J. Percy Priest Dam one of four spillway gates did not initially operate. This resulted in additional gate openings to account for the outages. LRN will enhance communication between its Water Management and its operations elements responsible for scheduling project maintenance outages. This will ensure that scheduled maintenance is performed at the best time with respect to water control operations.

6.3.2 Hours of Operation

Issue 19 covers the topic of triggers for the activation of the Corps WM offices. An experienced LRN Water Manager was on duty a large part of the time on Saturday. As part of their normal operating procedures, LRN WM provided project status and forecasts for the flood control projects to LRD WM. In turn, LRD WM provided this information to the NWS OHRFC in the morning report. The NWS OHRFC needed to discuss LRN reservoir operations late Saturday evening and early Sunday morning. They did not attempt to contact LRD WM until Sunday morning to obtain contact information for LRN WM. TVA also needed to contact LRD WM

DRAFT

during the Saturday night shift; however, an inexperienced TVA staff member did not know who to contact. LRN WM began 24-hour operations Sunday morning; however, LRD and LRN WM should have adopted that posture on Saturday in order to provide continuous monitoring communications with NWS and TVA. Each LRD river water management office is developing a Standard Operating Plan that includes common triggers with NWS for extended hours of operations and improved communications.

6.3.3 OHRFC/WFO Communication

Issue 20 addresses improving the understanding of technical information between the Corps and the NWS. On Sunday LRN and the NWS OHRFC began to discuss the operation of Old Hickory Dam during conference calls. Scheduled conference calls were at 0830 hours and 1330 hours. LRN initiated a series of spillway gate increases at Old Hickory at 1000 hours as a result of the increasing lake levels resulting from the additional rainfall. LRN did not communicate these gate increases to the NWS until the next regularly scheduled call, at 1330 hours. LRN and NWS did discuss the spillway gate change operations during the afternoon conference call on Sunday. By this time Old Hickory was above its surcharge pool level and nearing the pool of record. LRN intended during the afternoon call to indicate that gate operations were made to pass all inflow to the dam, with the intent of preventing further rises in the Old Hickory pool level. LRN also noted that discharges at this time were above their gate rating curves. LRN assumed that based on this information, the NWS would run its models as if the project was no longer present. However, the NWS felt that since the Corps was operating the spillway gates, their rated discharges were still reflective of current flow conditions. The NWS OHRFC did not understand the hydraulics of the navigation project operations on the Cumberland River system under the full range of flow conditions. The discrepancies between NWS model outflows and Corps releases were not fully discussed or understood on Sunday as observed precipitation exceeded forecast and the river stage approached critical levels in Nashville. The lower projected QPF, coupled with these misunderstandings, affected the accuracy of the NWS OHRFC early forecasts.

Since the 1970s, the information provided to the NWS OHRFC by LRN WM during high flow events had consisted of a plan of operation for the LRN flood control projects (Wolf Creek, Dale Hollow, Center Hill, and J. Percy Priest) and not flow data from the mainstem navigation projects (Cordell Hull, Old Hickory, and Cheatham). LRD WM provided the Barkley flows. LRN understood the modeling approach used by the NWS OHRFC was to pass inflow at the mainstem projects where only the surcharge pool storage was available and to route the releases from the flood control projects to develop stage forecasts at the damage centers. LRN WM employed that methodology for the data exchange when the May 2010 flood event began. The LRN senior water managers on duty had employed this same routine since 1984 on a daily basis. LRN applied this methodology during 16 high flow events resulting in a Nashville stage greater than 30 feet during this 26 year period. For the May 2010 flood event the NWS OHRFC was expecting more detailed information on releases from the mainstem projects. Once LRN realized that expectation around 2300 hours Sunday, the updated spillway gate operations were routinely shared with NWS staff. As observed on Figure 14, the NWS forecast accuracy increased.

DRAFT

The Corps and NWS will develop a better understanding and appreciation of each other's models and operations. As discussed in Issue 19, the Standard Operating Plan being developed will address common triggers for extended hours of operations and improved communications.

Issue 22 addresses improving communications between the Corps and NWS. LRD WM contacted the NWS OHRFC to inform them of high releases from Kentucky Lake and Lake Barkley; however, the NWS hydrologist on duty asked LRD to contact the NWS Paducah WFO directly in lieu of the LMRFC. LRD WM contacted the Paducah WFO as requested and the Paducah WFO issued a Special Weather Statement in lieu of a flood warning statement that would have activated the Emergency Alert System. The Service Hydrologist at the Paducah WFO did not fully understand the information provided by LRD. The flow information that LRD provided was not translated to stage thus, the Paducah WFO did not fully recognize the extent of the increase. Technical communication and lack of understanding of each agency's operations played a large role in this misunderstanding. When working with WFOs, the Corps should translate flows to river height levels whenever possible. LRD WM LMRFC and NWS OHRFC will develop, as part of the previously mentions SOP, an interagency process that specifies the correct language and emergency activation system levels for communicating urgent events regarding operation of Corps projects. This will ensure a common operational picture and appreciation for rapidly developing events.

6.3.4 Internet Outage

Issue 21 addresses implementing a redundant Water Management Enterprise Architecture. LRN lost internet connectivity between 0930 hours and 2005 hours on Sunday due to a Verizon line break. As a result of the network outage, the flow of rainfall, stage and flow data was disrupted. Prior to this event, LRN was in the process of relocating the water control database from outside of the production area to inside the production area. This impeded LRN WM staff's ability to obtain data and to post project data. To overcome this obstacle, the LRN WM staff utilized a personal cell phone with internet connectivity to obtain data. LRN is purchasing air cards, laptops and cell phones for the Water Management staff to provide redundant internet capability. Additionally, LRN WM is evaluating alternatives for internet access and developing alternative methods to interface with the water control data that are not solely dependent on network connection.

The NWS was also not aware that LRN data was available on an alternate web site (Rivergages.com). Because the public also relies on Corps websites, the LRD, LRN, NWS and USGS will improve its websites to facilitate public awareness that information is also available on other websites.

6.3.5 Quantitative Precipitation Forecasts (QPF) and Forecasts

Issue 23 addresses sustaining the pre-event water management actions taken by LRN to reduce pools at Cordell Hull, Old Hickory and Cheatham in advance of the storm based on the early Quantitative Precipitation Forecasts (QPFs). The challenge in pre-positioning lake levels is that by the time there is enough confidence in a rainfall forecast to warrant taking preventative measures, there is not enough time to significantly lower lake levels and clear water from downstream areas to avoid increasing the water levels downstream. The adjustments made to lake levels prior to the start of the event were appropriate given the magnitude of the initial

DRAFT

rainfall forecast. It is highly unlikely that the science behind rainfall and runoff forecasts will ever evolve to the point that lake level adjustments of a magnitude necessary to effect significant flood crest reductions can be made in advance of a major rainfall event. A shift of only 50-100 miles of the rainfall from the May 2010 event would have completely changed the outcome. The Corps and NWS will develop a program that takes advantage of tools either currently in use or under development at the NWS to prepare project inflow forecasts based on the latest forecasted rainfall information. Advances in probabilistic forecasting and technological updates such as the implementation of CWMS-based models in the Cumberland River System by LRN will provide the necessary framework for this work to move forward.

Issue 24 addresses improving awareness of QPFs by LRN WM. The NWS's Hydrometeorological Prediction Center publishes a national QPF twice a day in the morning and in the evening. The LRN WM water managers do not routinely check the NWS evening forecasts, which post after standard work hours. LRN did not review the Friday evening NWS forecast until Saturday morning. In this instant, failure to review the forecast did not impact flood operations; however, LRN WM is implementing policy changes to insure that NWS QPF forecasts are monitored during off-duty hours.

Issue 25 addresses improving the situational awareness of the NWS published forecast. LRN learned of changes to crest forecasts by news broadcasts; the NWS was not aware that the Corps was not receiving the current forecasts. LRN will implement steps to configure the Local Data Manager (LDM) software, which will allow its office to receive the NWS suite of products in real-time from LRD.

6.3.6 Loss of Gage Data

Issue 26 discusses improving the long term reliability of rainfall and stream gages. LRN WM staff, contract personnel, and the USGS collectively operate and maintain rainfall and stream gages within the Cumberland Basin. The LRN stream gaging maintenance contract expired on April 30, 2010, the day before the high rainfall for this event started. LRN WM staff performed emergency repairs on four Corps funded stream gages damaged during the event. The Tennessee USGS office contacted LRN WM during the flood and offered assistance. LRN WM is evaluating individual gage locations with respect to inundation potential. They are in the process of entering into a formal partnership with the Kentucky and Tennessee USGS offices through participation in the Cooperative Stream Gaging Program to maintain their gages.

6.3.7 Operation of the Cumberland River Basin System

Issue 27 addresses the ability to sustain operation of the Cumberland River Basin reservoir system under extreme conditions. The water control manuals were last updated in 1998 and these updates were largely updates of the original manuals. The magnitude, duration, and location of the rainfall during this event were such that flood stages along the Cumberland River were elevated to new record levels. The information contained in the water control manuals did not cover the full range of operations required to respond to this record rainfall event. For example, the spillway rating curve for Old Hickory did not extend to the full range of required gate openings. As a result, in some instances LRN Water Managers were working with incomplete data sets. Reservoir system operations were further hampered by a prolonged network outage that occurred on Sunday. The magnitude of this event required LRN Water

DRAFT

Managers to extrapolate from guidance in the water control manuals. The three LRN WM team members making the operational decisions each had thirty plus years of direct water management experience and had been through multiple high water events in the Cumberland River Basin. Their experience of knowing when and how to deviate from direct application of the water control manuals can be credited with preventing additional flood damages and perhaps saving several lives in the basin. A chronological analysis of water control actions taken during this event is presented in the issue and an explanation of when deviations from the water control manuals occurred. LRD and LRN will address the need to update the water control plans for the Cumberland Basin projects.

DRAFT

Appendix A – Cost Information

Table 1 – Corps Account Summary.

Corps Account Summary

STATE	FCCE	FEMA	O&M*
KY	**$100,000**	**$0**	**$6,589,240**
TN	**$333,000**	**$2,835,000**	**$43,671,560**
TOTAL	**$433,000**	**$2,835,000**	**$50,260,800**

*** Includes emergency operations and estimated damages.**

Table 2 – FCCE Summary of Class 200 Funding.

FCCE Summary

	FCCE	
Class	**KY**	**TN**
219 EOC Activation	$100,000	$116,000
219 Response Ops	$60,000	
219 HWM	$107,000	
249 Sandbags	$50,000	
	$100,000	**$333,000**

DRAFT

LRN-OP Budget personnel duties during Emergency Operations

- Fund Control: Assist in the management of funding, Load and track
- CEFMs Preparation: Military Interdepartmental Purchase Request, Customer Orders, Labor and Contractual PR&Cs.

The primary role of LRN –OP Budget section during the flood fight was to control funding for responders and other associated missions. This allowed the Emergency Management Section to focus on the task at hand.

All funding was entered and monitored in ENGLink[20]. This allowed tracking by LRD-EM and others as the mission and spending progressed.

Table 1 illustrates the Corps account summary for this event and includes the emergency operations and damages to the Corps projects.

Table 2 shows the Class 200 funding received for this major flood event.

DRAFT

[20] **ENGlink is the software program use by USACE to manage information, execution and personnel in response to an event. It also contains a database of all Corps personnel to document physical status, training and essential personnel data.**

Appendix B – PL84-99: Separate Projects and Major Activities

Martins Fork

Project: Martins Fork Lake

Location: Harlan County, Kentucky, Mile 15.6 on Martins Fork of Clover Fork, Cumberland River

The Flood of May 2010 resulted in a peak project headwater of 1322.2 feet MSL, 12.2 feet above normal summer pool, and peak discharge of 515 cfs at Martins Fork Lake.

Martins Fork Lake sustained no damages as a result of the Flood of May 2010.

Laurel

Project: Laurel River Lake

Location: Laurel River Mile 2.3, Laurel and Whitley Counties, Kentucky

The Flood of May 2010 resulted in a peak project headwater of 1,016.1 feet MSL, 2.4 feet below spillway crest, and peak discharge of 3,710 cfs at Laurel River Lake.

Laurel River Lake sustained no damages as a result of the Flood of May 2010.

Wolf Creek:

Project: Wolf Creek Dam – Lake Cumberland

Location: Cumberland River Mile 460.9, Russell County, Kentucky

The Flood of May 2010 resulted in a peak project headwater elevation of 703.86 feet, which is 23.86 feet above the target headwater under the current IRRM plan. Peak project discharges during the event were 14,880 cfs through a combination of sluice and turbines.

During the week prior to the Flood of May 2010, Wolf Creek Dam was operating four hydropower units around the clock. This was in response to rainfall over the basin the week before, and in order to manage the reservoir for the DSAC I interim risk reduction measure (IRRM) pool restriction target pool elevation of 680 feet.

Between 2400 hours on Sunday, May 2, and 0000 hours on Tuesday, May 4, all hydropower releases were discontinued in order to store water to reduce flows downstream during the flood crest. Beginning at 0000 hours on Tuesday, May 4, project discharges were resumed in

DRAFT

accordance with the water control manual procedure to evacuate flood control storage as fast as practical after the flood crest has passed in order to prepare for future potential floods.

Wolf Creek had extensive foundation treatment completed in this past year along with extensive instrumentation and automated real time instrumentation readings that indicate any issues of possible distress in the dam and foundation. The potential for exceeding the interim operating levels at Wolf Creek on a short duration/temporary basis during floods have been factored into the projects risk analysis and do not place the dams at risk.

Flood damages sustained at Wolf Creek Dam,Lake Cumberland, are estimated at $1.2M. Slope failures occurred at the main campground and debris was deposited throughout the project area.

Dale Hollow

Project: Dale Hollow Lake

Location: Obey River Mile 7.3, Clay County, Tennessee

The Flood of May 2010 resulted in a peak project headwater elevation of 657.34 feet MSL. Peak project discharges during the event were 2,005 cfs through a combination of fish hatchery and turbines releases.

Prior to the Flood of May 2010, one hydropower unit was running around the clock for routine reservoir level management at Dale Hollow Lake.

Between 2300 hours on Sunday, May 2, and 1500 hours on Monday, May 3, all hydropower releases were discontinued in order to store water to reduce flows downstream during the flood crest. Beginning at 1500 hours on May 3, in response to a special request by TVA to address a power transmission line problem associated with Dale Hollow be off-line, one hydropower unit was placed into service. This action was consistent with guidance in water control manuals with respect to recovering flood control storage after the flood crest has passed.

Flood damages sustained at Dale Hollow Lake are estimated at $1.2M. Recreation areas and access roads across the project were impacted by the high water, debris load, and erosion caused by the heavy rains.

Center Hill

Project: Center Hill Lake

Location: Caney Fork Mile 26.6, DeKalb County, Tennessee

The Flood of May 2010 resulted in a peak project headwater elevation of 646.76 feet MSL, which is 16.76 feet above the top of the operational band defined in the current IRRM plan. Peak project discharges during the event were 3,750 cfs through the hydropower turbines.

DRAFT

Prior to the Flood of May 2010, reservoir levels were being managed through a combination of constant sluice releases and hydropower pulsing operations. At 1000 hours on Saturday, May 1, one hydropower unit was brought on-line and run continuously for the remainder of the day. This decision was based upon the observation of radar rainfall amounts and the near certainty that the Caney Fork watershed was going to receive excessive rainfall. The action was taken to conserve flood control storage and to manage the lake level in accordance with the IRRM pool restrictions in place. At the time, the additional flow did not pose a threat to Carthage, the downstream damage center at the confluence of the Caney Fork and Cumberland River.

Between 2100 hours on Sunday, May 2, and 0000 hours on Tuesday, May 4, the total project discharge was reduced to zero in anticipation of discharges at Cordell Hull being increased above the control flow limit at Carthage. Beginning at 0000 hours on Tuesday, May 4, project discharges were resumed in accordance with the water control manual procedure to evacuate flood control storage as fast as practical after the flood crest has passed in order to prepare for future potential floods.

Center Hill had extensive foundation treatment completed in this past year along with extensive instrumentation and automated real time instrumentation readings that indicate any issues of possible distress in the dam and foundation. The potential for exceeding the interim operating levels at Center Hill on a short duration/temporary basis during floods have been factored into the projects risk analysis and do not place the dams at risk.

Flood damages sustained at Center Hill Lake are estimated at $150K. The access road to the saddle dam sustained damage, boundary lines have been washed away, and mud, silt, propane and fuel tanks, and household chemicals have been deposited in parking areas, on boat ramps, and recreation areas in the project.

J. Percy Priest

Project: J. Percy Priest Dam and Reservoir

Location: Stones River Mile 6.8, Davidson County, Tennessee

The Flood of May 2010 resulted in a peak project headwater elevation of 504.9 feet MSL. Peak project discharges during the event were 8,600 cfs through a combination of spillway and turbine releases.

Prior to the Flood of May 2010, as a part of the normal process of filling the reservoir to summer pool elevation, there were no discharges from the project. At 1000 hours on Saturday, May 1, the lone hydropower unit was brought on-line. This decision was based upon the observation of radar rainfall amounts and the near certainty that the Stones River watershed was going to receive excessive rainfall.

At 1000 hours on Sunday, May 2, when discharges from Old Hickory Lock and Dam reached 90,000 cfs, and when, according to the water control manual discharges from J. Percy Priest should be stopped, the hydropower discharges were continued in order to reserve storage in the reservoir for when the flood crest approached Nashville.

DRAFT

Between 2100 hours on Sunday, May 2, and 0715 hours on Monday, May 3, the total project discharge was reduced to zero in order to manage the crest along the Cumberland River at Nashville, forecast for 0100 on Monday, May 3. Beginning at 0715 hours on Monday, May 3, with the crest apparently still several hours from reaching Nashville, the hydropower unit was brought back on-line in order to preserve the remaining storage in the reservoir.

A surcharge operation was initiated at 2330 hours on Monday, May 3, as the reservoir elevation reached the top of the spillway gates at elevation 504.5 feet MSL. The plan to open all 4 spillway gates 0.5 feet as the reservoir reached 504.5 was hindered when one of the gates did not function properly. While emergency repairs were undertaken, one of the gates was opened to 1.0 foot instead. At 2400 hours, with the gate repaired, all 4 gates were opened to 0.5 foot resulting in a total discharge of 7,000 cfs. This discharge was maintained until 0800 hours on Tuesday, May 4, when, due to a reservoir which continued to rise, the gates were opened an additional 0.3 foot each, increasing the project discharge to 8,600 cfs. This configuration was maintained until 1100 hours on Friday, May 07, when the total discharge was increased to 10,100 cfs to continue evacuating water from storage in order to prepare for future potential floods.

Flood damage sustained at J. Percy Priest is estimated at $3.2M. Rip rap bank protection at the project has been washed away in numerous areas. Access roads, parking lots, and launching ramps have been damaged by severe erosion or blocked with drift and debris deposited by the flooding. Roadways and parking lots have been undercut and asphalt surfacing has crumbled in many places. Riprap at boat ramps has been washed out. Recreation areas across the project have been impacted by the high water event. Multiple campsites and picnic sites have been eroded and covered with mud, and have been taken out of service. Waste receptacles have been washed away and electrical hookups have been damaged and placed out of service. Picnic shelters have been affected by drift, debris, and erosion. Signs and bulletin boards have been damaged or destroyed by water and erosion. Retaining walls and handicap access points have also been affected by erosion and wave action resulting in damage of varying degrees.

Cordell Hull

Project: Cordell Hull Dam and Reservoir

Location: Cumberland River Mile 313.5, Smith County, Tennessee

The Flood of May 2010 resulted in a peak project headwater of 508.33 feet MSL. A maximum discharge of 130,100 cfs was required in order to keep the pool elevation from overtopping the upstream lock miter gates.

Prior to the Flood of May 2010, based upon National Weather Service rainfall forecasts, the Cordell Hull Dam and Reservoir pool elevation was lowered approximately 0.5 foot. This adjustment was within normal reservoir levels, and was performed to better position the reservoir system to be able to manage the forecasted rainfall totals.

Beginning at 1730 hours on Saturday, May 1, spillway discharges were initiated at Cordell Dam and Reservoir at a rate of approximately 5,000 cfs/hr until a total discharge of 50,000 cfs was reached. As the reservoir reached elevation 505.25, the discharge was increased to 60,000 cfs

DRAFT

and held steady in an effort to keep the Cumberland River from reaching flood stage at Carthage, TN and to limit the volume of water entering Old Hickory downstream.

In response to the slow moving and intense rainfall, starting at 2200 hours on Sunday, May 2, a series of spillway gate increases were required to manage the reservoir elevation and prevent overtopping of the upstream lock miter gates. Spillway gate increases as often as every 30 minutes, and corresponding discharge increases as much as 10,000 cfs each, continued through the night. By 1100 hours on Monday, May 3, the reservoir had dropped back below the elevation 508.0 feet MSL surcharge storage threshold allowing spillway discharge reductions to be made in an effort to protect Carthage. Discharge reductions were made as aggressively as possible without allowing the reservoir to rise above elevation 508.0 feet MSL.

As local runoff to Cordell Hull receded between 0000 hours and 0500 hours on Tuesday, May 4, a series of spillway discharge reductions were made to reach control flow of 72,000 cfs. All gates at Cordell Hull were closed at 0600 hours on Wednesday, May 5.

Flood damages sustained at Cordell Hull Dam and Reservoir are estimated at $4.5M. The debris load, and force of the flood, damaged spillway gates and components, damaged underwater spillway structures, cluttered the forebay with riprap and debris, damaged railings, lighting system components, and steel plating on the lock, and left recreation areas covered with debris. Depth markers and buoys were washed away, as well as the sand on recreation beaches. Extensive erosion to access roadways and parking areas was experienced. The rip rap protecting the channel banks downstream of the project has been damaged, and several government vehicles were lost during the flood.

Old Hickory

Project: Old Hickory Lock and Dam

Location: Cumberland River Mile 216.2, Davidson and Sumner Counties, Tennessee

The Flood of May 2010 resulted in a peak project headwater of 451.45 feet MSL, and required an estimated maximum discharge of 212,260 cfs in order to control reservoir levels.

Prior to the Flood of May 2010, based upon National Weather Service rainfall forecasts, the Old Hickory Lock and Dam pool elevation was lowered approximately 0.5 foot. This adjustment was within normal reservoir levels, and was performed to better position the reservoir system to be able to manage the forecasted rainfall totals.

Beginning at 1200 hours on Saturday, May 1, spillway discharges were initiated at Old Hickory Lock and Dam at a rate of approximately 5,000 cfs/hour until a total flow of 75,000 cfs was reached at 2300 hours on the same day. This discharge was held in an effort to allow local inflows to recede downstream, until 1000 hours on Sunday, May 2, when a series of spillway discharge increases were required as a result of rapidly increasing reservoir elevations. Spillway discharge increases as often as every 15 minutes, and as much as 10,000 cfs each, were necessary to prevent the upstream lock wall from being overtopped. Had the pool climbed 0.55 feet higher it would have overtopped the upstream lock wall, resulting in flooding of the

DRAFT

powerhouse, and requiring complete evacuation of the dam. It has been estimated that such an event would have resulted in a flood crest 4 feet higher in Nashville than was actually experienced.

At 2100 hours on Sunday, May 2, the first spillway discharge reductions were made to manage the crest at Nashville that was forecast at that time to occur at 0100 hours on Monday, May 3. Additional reductions were made through the night, however at 0300 hours on Monday, May 3, spillway discharge increases were again required as large discharges from Cordell Hull and local uncontrolled runoff had pushed the reservoir dangerously high.

In an effort to reduce the flood crest through Nashville, and protect the lone remaining water treatment plant for the city, spillway discharges were able to be reduced beginning at 1300 hours on Monday, May 3. Between 1300 hours and 1700 hours the total discharge out of Old Hickory Lock and Dam was reduced from 196,500 cfs to 144,200 cfs. These spillway gate settings were held until 0900 hours on Wednesday, May 5 when a series of spillway discharge reductions were made in response to steadily declining inflow to the project. By the end of the day on Thursday, May 6 Old Hickory Lock and Dam was back within its normal operating range.

Flood damages sustained at Old Hickory Lock and Dam are estimated at $11.5M. The debris load, and force of the flood, damaged spillway gates and components, the tail deck crane and collector rails, underwater spillway structures, capstans, handrails, and power cables on the lock and dam, and left large amounts of debris in the intake trash screens. Large amounts of debris were deposited on the tail deck and in the left bank tailwater area. The tail deck crane was knocked off of its rails and sustained damage. Severe erosion has occurred on the dam embankments and abutments resulting in destabilization of slopes, and on the bluff adjacent to the switchyard resulting in slope instability which threatens the access road to the power plant as well as the parking lot. Damage occurred at numerous recreation areas and associated facilities, and propane and fuel tanks, and household chemicals have been deposited at various areas across the project. Several campsites were inundated and electrical hookup facilities damaged by water. The nature trail by the dam was impacted as high water washed away the boardwalks and deposited tons of debris. The stream gage on Bledsoe Creek was lost during the event due to the extreme high water.

Cheatham

Project: Cheatham Lock and Dam

Location: Cumberland River Mile 148.7, Cheatham and Dickson Counties, Tennessee

The Flood of May 2010 resulted in a peak project headwater of 404.15 feet MSL with a corresponding maximum discharge of 240,000 cfs.

Prior to the Flood of May 2010, based upon National Weather Service rainfall forecasts, the Cheatham Lock and Dam pool elevation was lowered approximately 1.0 foot. This adjustment was within normal reservoir levels, and was performed to better position the reservoir system to be able to manage the forecasted rainfall totals.

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Cheatham Lock and Dam was designed to allow overtopping of the lock and spillway gate section without threat of failure. The Power Plant is at a higher elevation and does not become inundated during extremely high flows such as those observed during this event. When the river flow past Cheatham exceeds the flow which can be regulated by the seven available spillway gates, the gates are lifted out of the water and the river goes to what is referred to as free flow.

By 1900 hours on Saturday, May 1, Cheatham Lock and Dam had gone to free flow. It remained in that condition until Saturday, May 8, when the spillway gates were placed back in service and the project returned to "normal" operations.

Flood damages sustained at Cheatham Lock and Dam are estimated at $23.7M. Floodwaters overtopped the lock walls at Cheatham by more than 12 feet at crest. The debris load, and force of the flood, severely damaged spillway gates and components, damaged the power plant trash boom and control cables, and left submerged debris on the powerhouse intake trash screens. Major electrical components at the project were destroyed including high voltage transformers, breakers, feeder cables and auxiliary feeder cables. The hydraulic systems were left inoperable but repairable. The lock tow haulage system was completely wrecked, along with the camera monitoring system. The lock operations building's basement and first floor sustained severe damage which will require complete rehabilitation. The resource manager's office at the project, along with all contents, was destroyed. The lock maintenance shop and office, equipment, tools, and several government vehicles were a total loss. The project security fence and perimeter control have been knocked down completely. Severe erosion, resulting slope instabilities, and loss of bank protection rip rap have occurred throughout the project where boundary lines have been washed away, and propane and fuel tanks, and household chemicals have been deposited throughout the area. Corps-managed recreation areas on the lake were severely damaged or destroyed by flood waters. Restrooms and shower houses were flooded; electrical equipment and wiring were destroyed or damaged. Drift and mud were deposited on parking lots, campsites, boat ramps, and picnic areas. Campsites and picnic sites were washed out. Playground equipment was damaged or destroyed. Beach areas were washed out and covered with drift and debris. Large trees were knocked over in the right bank area. Electrical service equipment at campgrounds was damaged or destroyed. Picnic tables, trash receptacles, grills, and other amenities were washed away. Picnic shelters were damaged and covered with mud and debris.

Barkley

Project: Barkley Dam and Lake Barkley

Location: Cumberland River Mile 30.6, Lyon and Livingston Counties, Kentucky

The Flood of May 2010 resulted in a peak project headwater of 369.00 feet MSL with a corresponding maximum discharge of 303,200 cfs.

Prior to the Flood of May 2010, Barkley Lock and Dam was discharging a total of approximately 43,000 cfs through a combination of turbine and gate releases.

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On May 1, when the criteria were met for lower Ohio-Mississippi flood control, LRD assumed direction of Lake Barkley releases.

On May 1, Barkley discharges were increased based on forecast rainfall. On May 2, a series of spillway discharge increases was initiated at Barkley Lock and Dam beginning at 1000 hours. By 2400 hours that day, spillway discharges had been increased to 156,500 cfs. This was done to preserve flood storage in the Barkley and Kentucky reservoirs for later in the flood event, as well as to address a flood crest that was moving down the Ohio River from rainfall that occurred several days earlier in the Ohio Basin.

By 0900 hours on Monday, May 3, total discharges from Barkley Lock and Dam had been increased to 260,000 cfs. At 1200 hours, a series of 10,000 cfs/hour spillway discharge increases were initiated to bring the total discharge to 300,000 cfs.

In response to flooding downstream of the project, spillway discharge reductions were made at 1900 hours on Monday, May 3. A total of two spillway gate changes were made which reduced the total project discharge to approximately 280,000 cfs.

When the Barkley project experiences extremely high tailwater elevations like it did on this date, a submergence problem is encountered with operation of the spillway gates. The Barkley spillway gates must be clear of the water on the tailwater side when in operation or they will be subject to extreme vibration. Therefore, a gate must be either closed or open high enough to clear the tailwater. As a result, operators and water managers are sometimes unable to produce the desired flow and must decide on either a flow lower than the target or higher. The differences can be fairly significant since extremely large gate openings are required at the individual gates. The Barkley power plant operators were forced to make a series of gate changes between 0500 hours and 0805 hours on Tuesday, May 4, to address submergence problems. The final result is the project discharge was higher than the target during this period, and set a new record of 303,200 cfs at 0800 hours.

At 0800 hours on Tuesday, May 4, project discharges reductions to 240,000 cfs were targeted, but due to submergence the closest operators could get was 266,000 cfs by completely closing one spillway gate. At 1600 hours one additional spillway gate was closed resulting in a total discharge of 230,000 cfs.

By 1900 hours on Wednesday, May 5, after a series of spillway discharge reductions, starting at 1000 hours that day, to support ongoing flood control operations for the lower Ohio River, total discharges from Barkley Dam and Lake Barkley were 150,000 cfs.

Total discharges were further reduced to 120,000 cfs between 1000 and 1200 hours on Saturday, May 8, where they remained until May 17 when discharges were reduced to 70,000 cfs.

Flood damages sustained at Barkley Dam and Lake Barkley has been estimated at $5.3M. The debris load and force of the flood, caused damage to spillway gates and components, left debris submerged on powerhouse intake screens, and washed away bank protection rip rap allowing severe erosion and bank instabilities to materialize. Propane and fuel tanks, household chemicals and other wastes have been deposited throughout the project, including mud and silt in recreations areas, propane and fuel tanks piled up in various areas of the project. The dam

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inspection roadway sustained damage, as well as other access roads and parking areas at the project.

Major Activities

Major flood fight activities directly, or indirectly, supported by LRN were the sandbagging of Metro Center Levee and the Omohundro Water Treatment Plant.

The District provided 62,000 sandbags to the state of Tennessee, and arranged delivery of those sandbags to the State Emergency Operations Center on May 1-3. These assets were distributed by the State.

A technical expert, the District Levee Safety Program Manager, was dispatched to Metro Center Levee on Monday, May 3 to provide assistance in determining a plan of operations for sandbagging the levee. The sandbagging operation itself was carried out by a team of local volunteers.

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Appendix C – FEMA Mission Assignments

Pre-Declaration STATE	Mission Assignment Number	Description	Amount
Tennessee	7220SU-TN-COE-LRD-01	Regional Activation	$20,000
Total			$20,000

Post Declaration STATE	Mission Assignment Number	Description	Amount
Tennessee	1909DR-TN-COE-LRD-01	Regional Activation	$300,000
Tennessee	1909DR-TN-COE-LRD-02	Water/Wastewater	Cancelled
Tennessee	1909DR-TN-COE-LRD-03	Debris Oversight	$500,000
Tennessee	1909DR-TN-COE-LRD-04	Water/Wastewater Infrastructure	$400,000
Tennessee	1909DR-TN-COE-LRD-05	GIS Support	$115,000
Tennessee	1909DR-TN-COE-LRD-06	Project Worksheets	$1,500,000
Total			$2,815,000

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Appendix D – Corps Timeline of Events

This Great Lakes and Ohio River Division (LRD) and the Nashville District (LRN) water management events are in this timeline.

Date	Time (CDT)	Event
28-Apr	700	5-Day QPF issued showing storm system of up to 6.2 inches
29-Apr	0	Nashville stage - 18.50
	600	Nashville stage - 18.75
	700	5-Day QPF issued showing storm system of up to 6.6 inches
	800	WFO Nashville morning data received by LRN WM
	816	LRN WM observed data sent to NWS
	854	LRD sends a Flood Potential Update to the LRD Senior Leaders, EM and PAO
	1146	LRN WM forecast data sent to NWS
	1200	Nashville stage - 19.02
	1700	3-Day QPF issued
	1800	Nashville stage - 19.46
30-Apr	0	Nashville stage - 19.77
	416	3-Day QPF issued
	600	Nashville stage - 20.08
	700	5-Day QPF issued showing storm system of up to 7.8 inches
	800	WFO Nashville morning data received by LRN WM
	801	LRN WM observed data sent to NWS

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Date	Time (CDT)	Event
30-Apr	1000	LRD and TVA make QPF model runs forecasting Cairo, IL to reach a stage of 40 ft and Kentucky Lake to reach 363.5. The official NWS forecast is for 37 ft at Cairo, IL.
	1146	LRN WM forecast data sent to NWS
	1200	Nashville stage - 20.17
	1314	Although the NWS forecast does not indicate reaching the criteria for LRD to take direction of Kentucky and Barkley Lakes, LRD orders the Districts to staff water management for the weekend and arranges staffing for its office.
	1800	Nashville stage - 19.68
	2138	3-Day QPF issued
1-May	0	Nashville stage - 19.01
	435	3-Day QPF issued
	600	Nashville stage - 18.83
	700	5-Day QPF issued showing storm system of up to 8.6 inches
	700	Rainfall totals for the past 24 hours range from 0.5-4 inches of the AOC
	700	LRD initiates coordination with TVA
	715	LRD initiates coordination with LMRFC
	716	LRN WM observed data sent to NWS
	730	LRD initiates coordination with LRN
	0800	LRD calls OHRFC to obtain an updated weather forecast
	1000	Start hydropower releases at J. Percy Priest
	1200	Start spillway discharges at Old Hickory

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Date	Time (CDT)	Event
1-May	1200	LRD provides afternoon TVA release schedule to LMRFC and LMRFC produces a Cairo, IL stage forecast of 41 feet
	1200	Nashville stage - 20.79
	1242	LRD Assumes direction of Kentucky and Barkley Lakes; no changes to the release schedule are made
	1319	Water Management Update is sent to an extensive notification list that a flood control operation has been initiated and provides an assessment of the severe weather, past 24 hours rainfall and QPF
	1701	3-Day QPF issued
	1730	Start spillway discharges at Cordell Hull
	1800	Nashville stage - 28.04
	1900	LRN Water Management increased staff. Cheatham goes to free flow.
	2200	OHRFC has stated that it tried to contact LRN WM to get updated forecast. LRN WM office was manned from 1900-2300. LRN WM did not receive any calls or messages from OHRFC during this period.
	2230	LRN notifies District Senior Leadership and LRD WM via e-mail of the potential for Nashville to reach flood stage and exceed the 1984 crest of 45 ft. The NWS forecast is for a crest of 36.2 ft overnight.
2-May	0	Nashville stage - 34.52
	1	Spillway releases brought up to 60,000 cfs range at Cordell Hull
	416	LRD forwards LRN's e-mail message forecasting flood stage and above at Nashville to the Ohio River Forecast Center.

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Date	Time (CDT)	Event
2-May	427	LRD forwards LRN's e-mail message forecasting flood stage and above at Nashville to the LRD Senior Leadership.
	452	3-Day QPF issued
	600	Nashville stage - 37.33
	638	OHRFC contacts LRD and indicates they cannot reach anyone in LRN. The LRN WM office was manned starting at 0630 Sunday morning - no phone calls or messages from the OHRFC were received. OHRFC indicates they have updated the Nashville forecast to 40 feet. LRD arranges for a 0830 coordination call between LRN, LRD and OHRFC.
	700	Rainfall totals for the past 24 hours range from 4-8 inches of the AOC; two day totals are 7 to 10 inches
	700	1-Day QPF issued showing storm system of an additional 0.25 to 4 inches of rain
	700	WFO Nashville morning data received by LRN WM
	700	LRD exchanges data with TVA
	715	LRD exchanges data with LMRFC indicating the release schedule is expected to change substantially
	730	LRD exchanges data with LRN; LRN is engaged in the flood fight
	730	LRN reports network loss; continues to receive river and reservoir data via satellite communications to the CORPS network through Rivergages.com; LRD's Direct Readout Ground Station continues to provide the Nashville data to Rivergages.com
	746	LRN WM observed data sent to NWS
	830	NWS/CORPS coordination conference call

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Date	Time (CDT)	Event
2-May	830	Coordination call is conducted between LRN, LRD and OHRFC and the LRN WM strategy is related
	930	Network Outage reported
	930	Nashville Gauge reaches flood stage
	950	NWS forecasted Nashville crest 41.9 on 5/2 at 1900
	1000	Start rapid spillway release increases at Old Hickory and start spillway release increases at Barkley
	1000	TVA provided its updated Kentucky and Barkley release schedule and Kentucky pool forecast. However, this schedule and forecast did not have updated Lake Barkley inflows (Cheatham outflows) from LRN as LRN had to manage the upper projects first. Based on the pool rise and the preliminary release schedule, TVA requested to begin increasing releases at Kentucky Lake by 30,000 cfs and by 10,000 cfs at Lake Barkley. LRD WM concurred, and orders were issued to the projects to begin increasing releases. LRD Senior Management and LRD Dam Safety were notified via e-mail that orders were given to start increasing releases.
	1040	OHRFC provided its public forecast for Nashville of 41.9 ft, but noted that the Nashville stage was already 41 feet. OHRFC noted that the forecast would be updated at 18z (1:00 pm CDT)
	1100	LRD issued orders to begin increasing releases at Kentucky Lake by 30,000 cfs and at Lake Barkley by 10,000 cfs based on TVA's noon preliminary model updates. LRN had not yet provided Cheatham flows (inflows to Lake Barkley) so a final release schedule and pool forecast could not be made
	1118	NWS Forecasted Nashville crest 45.0 on 5/2 at 1900

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Date	Time (CDT)	Event
2-May	1136	LRD called LRN to let them know they urgently needed the Cheatham flows. LRN WM reported that LRN had just provided its estimate of Cheatham flows to TVA. LRN conveyed to LRD that the Cheatham flows were uncertain due to the rapidly changing hydraulic conditions as Cheatham became submerged and rain continued to fall and that the flows did not include any rain since 0600 hours.
	1145	Corps emergency manager sent to TEMA
	1200	Nashville stage - 42.61
	1230	TVA developed a new release schedule and pool forecast and reported it to LRD about 1230 hours. The schedule indicated a pool crest of 366.1 feet on May 4. This release schedule produced an Ohio River crest at Cairo, IL of 46.2 on May 7th, using the LRD Ohio River model. Discussion then ensued between LRD and TVA on multiple operating objectives including stabilizing the pool elevation at 365 feet and increasing discharges in advance of the Ohio River flood crest. TVA then returned to developing another schedule in light of the discussion.
	1300	Coordination call is conducted between LRN, LRD and OHRFC and the LRN WM strategy is related; it is apparent that critical conditions for J. Percy Priest, Old Hickory and Cheatham. The OHRFC notes the storm system has stalled and more rain is expected; the OHRFC issues a crest forecast for Nashville of 48.5 feet for the evening of 2 May
	1330	NWS/CORPS coordination conference call

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Date	Time (CDT)	Event
2-May	1400	Old Hickory pool of record 451.45. TVA proposed a revised schedule that achieved several objectives. The new schedule increased releases ahead of the Ohio River flood crest then reduced flows during the crest to prevent increasing flood damages on the lower Ohio River. Even with these high releases, the pool was forecast to continue to climb an additional foot to nearly 365 feet, and then stabilize. This elevation was still significantly above Lake Barkley's Storage Utilization Guide that provides the amount of storage that can be committed to a flood event. This elevation also begins to trigger dam safety concerns. Reductions in the pool were also sought to reduce backwater pressure upstream increasing levels at Clarksville and above. The uncertainty in the local and Cheatham inflows to the reservoirs and the rain still to fall in the next 24 hours increased the urgency to stabilize the pool levels in advance of the Nashville flood wave entering Lake Barkley. LRD WM conducted a teleconference with TVA and LRN to discuss the proposed release schedule. In light of the worsening conditions upstream of Lake Barkley and the record local inflows to both Kentucky Lake and Lake Barkley, the consensus was that the proposed discharges were necessary. LRD WM provided the final release schedule to the LMRFC.
	1430	The release schedule was then communicated to the following: Barkley Dam Tender, LRN Senior Leaders, LRD Dam Safety Officer, LRD Chief, EOC, LMRFC, OHRFC, Paducah WFO, and the Olmsted Project Office
	1500	The LRD WM Update is sent out

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Date	Time (CDT)	Event
2-May	1500	During a call with Metro Nashville EOC, the LRN DDPM is asked by the Nashville Mayor why the Corps was not feeding Metro information on the river levels. The LRN DDPM explained to the Mayor that the NWS was responsible for river stage forecast. When the Mayor responded that he thought Metro received that information from the Corps, his staff verified that they look to the NWS for river information.
	1530	LRD WM staff leaves the office
	1603	The NWS Paducah WFO issues the Special Weather Statement advising persons downstream of the Kentucky and Barkley dams to prepare for higher water immediately.
	1619	NWS forecasted Nashville Crest at 48.0 on 5/3 at 0100
	1643	WFO Nashville stated they relayed Nashville forecast to Corps and Corps was fairly confident Old Hickory could hold 150,000 cfs. At that time, Old Hickory was already 7 feet over maximum rated spillway opening (150,000 cfs). This represents an apparent breakdown in communication as LRN WM would not have made that statement.
	1700	Old Hickory gate opening 34 ft
	1800	Nashville stage - 46.86
	1828	NWS forecasted Nashville Crest at 48.0 on 5/3 at 0100
	1930	Air card provided by ACE-IT for internet connectivity for LRN WM
	1943	WFO Nashville calls LRN WM and leaves a message

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Date	Time (CDT)	Event
2-May	1950	LRN WM returns WFO Nashville's call. WFO Nashville states that JPP increased from 5,000 cfs to 10,000 cfs and cuts were anticipated at Old Hickory Dam but flow is currently 150,000 cfs. This represents another apparent breakdown in communication. The discharge information was characterized as the last reliable flow rating (within the spillway gate rating table) was 150,000 cfs, but that we had made several increases since then. There were no short term flow increases at J. Percy Priest implemented or considered during this event. LRN WM did pass along the information that spillway gate releases would be required at J. Percy Priest, but every attempt would be to delay that until after the crest passed through Nashville.
	2004	WFO Nashville informed OHRFC that JPP went from 5,000 cfs to 10,000 cfs for about an hour. This action was not considered during the event. JPP would cut back to zero at 2100 - this action was implemented to manage for the flood crest in Nashville. Old Hickory was now at 150,000 cfs. This is an apparent breakdown in communication as LRN WM was fully aware that the discharge from Old Hickory was greater than 150,000 cfs.
	2005	Network Restored
	2049	LRD Dam Safety Officer provides a Cumberland Basin Update/Actions to the Division Commander, Deputy Commander and the LRD Director of Programs.
	2100	Center Hill and J. Percy Priest hydropower generation stopped. Made first spillway reduction at Old Hickory.
	2200	NWS forecasted Nashville crest at 50.3 on 5/3 at 1300
	2200	Start rapid spillway release increases at Cordell Hull
	2300	Dale Hollow hydropower generation stopped

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Date	Time (CDT)	Event
2-May	2300	OHRFC called LRN WM. LRN WM advised to use 220,000 cfs as an estimate for Old Hickory discharge.
3-May	0	LRN WM called OHRFC and reported having trouble contacting Old Hickory
	0	Nashville stage - 49.63
	1	Wolf Creek Hydropower generation stopped
	20	LRN WM called OHRFC back. Cordell Hull opened up to 90,000 cfs. Old Hickory was going down by 5,000 cfs per hour to no lower than 175,000 cfs
	30	The Metro Water Services Director requested the latest information on Old Hickory releases and the plan for future releases. After a call to the LRN WM Chief, The LRN DDPM provided the requested information as of midnight 3 May.
	130	LRN WM called OHRFC and provided OLD update
	402	NWS Nashville crest forecast 51.5 on 5/3 at 1300
	500	Cordell Hull pool of record 508.33
	600	Celina crest 37.62
	600	LRD staff reports to Reservoir Control Center
	600	Nashville stage - 50.56
	601	LRN WM observed data sent to NWS
	630	Cordell Hull reaches max gate opening of 16 ft
	700	Total storm event rainfall is now between 10-15 inches over a widespread area
	700	Morning exchange of data with TVA and LRN
	700	WFO Nashville morning data received by LRN WM
	715	J. Percy Priest hydropower unit back on line

DRAFT

Date	Time (CDT)	Event
3-May	0718	LRN DDPM emailed the Metro Water Services Director the latest information on Old Hickory and J. Percy Priest discharges.
	725	NWS Nashville crest forecast 51.5 on 5/3 at 1300
	830	NWS/CORPS coordination conference call
	830	Coordination call with LRD, LRN, OHRFC
	900	Water Management Strategy is briefed at EOC with LRL and Kentucky EM; Discussion of releases on the town of Smithland is discussed as well as the possibility of Barkley tailwater going to 348 feet.
	1000	Release schedule for Kentucky and Barkley is finalized with TVA and LRN. Releases increasing up to 300,000 cfs are determined as necessary to ensure sufficient storage is available for the Nashville flood wave. LMRFC predicts a crest of 50 feet at Cairo, IL.
	1100	Initiated spillway discharge reductions at Cordell Hull
	1200	Carthage Crest 46.06
	1200	Nashville stage - 51.19
	1230	Conference call between LRN WM, WFO Nashville, OHRFC, and OEM
	1300	Initiated spillway discharge reductions at Old Hickory
	1330	NWS/CORPS coordination conference call
	1330	Afternoon coordination call with LRD, LRN and OHRFC and Nashville WFO
	1400	Attended emergency operations center call with HQ UOC.

DRAFT

Date	Time (CDT)	Event
3-May	1430	Coordination call between OHRFC and LRN WM to discuss if anything else could be done with JPP to hold the 52 feet at Nashville. Spillway releases at JPP were delayed as long as possible.
	1500	Barkley spillway discharge reaches 300,000 cfs. Dale Hollow hydropower unit back online.
	1523	Water Management Update is issued discussing the record flooding and release schedule from Kentucky and Barkley Lakes
	~1525	Corps EM Liaison sent to KYEM
	1542	NWS Nashville crest forecast 52.0 on 5/3 at 1900
	1600	LRD WM and the LRD Dam Safety Officer briefed the Division Commander and the LRD Director of Programs in the Executive Office on the flooding situation and LRD and LRN's flood control strategies.
	1700	EOC notifies WM of concerns for downstream flooding in the town of Iuka below Barkley Dam
	1730	Flow reductions are coordinated with TVA and LRN and approved by the LRD Dam Safety Officer with recognition that the pool level will rise
	1758	Paducah WFO issues Special Weather Statement warning of high pools, tailwaters and lake releases
	1800	Nashville Crest 51.86
	1830	Coordination call between LRN WM, OHRFC.
	1900	Made spillway discharge reductions at Barkley
	1956	Paducah WFO issues Flash Flood Warning

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Date	Time (CDT)	Event
3-May	2011	The LRN DDPM emailed the Metro Water Services Director to explain that water must be discharged to keep J. Percy Priest gates from being overtopped, but the increased flow out of Priest was less than the reductions that were occurring at Old Hickory.
	2025	WFO Nashville coordinates with LRN WM
	2115	LRN notifies LRD that the full reductions cannot be made as hydropower is offline and gate adjustments offer alternatives of 280,800 cfs or 235,000 cfs. LRD WM directs the flows to remain at 280,800 due to high risk of pool storage utilization
	2200	Cheatham pool of record 404.15
	2238	Senior leadership is notified and the LRD Dam Safety Officer concurs with the decision.
	2330	Surcharge storage operation at J. Percy Priest
4-May	0	Nashville stage - 51.27
	1	Wolf Creek and Center Hill hydropower units back on line
	400	Start spillway discharge increases at Barkley
	600	LRD staff reports to Reservoir Control Center
	600	Nashville stage - 50.47
	646	LRN WM observed data sent to NWS
	700	Clarksville Crest 62.58
	700	LRD exchanges data with TVA
	715	LRD exchanges data with LMRFC
	730	LRD exchanges data with LRN
	800	Barkley reaches maximum discharge of 303,200 cfs

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Date	Time (CDT)	Event
4-May	800	WFC Nashville morning data received by LRN WM
	830	NWS/CORPS coordination conference call
	830	Coordination call with LRD, LRN, OHRFC
	1000	Release schedule for Kentucky and Barkley is finalized with TVA and LRN. Releases are starting to be reduced in anticipation of Cairo, IL crest
	1200	Wolf Creek added additional hydropower unit
	1200	Nashville stage - 50.02
	1330	NWS/CORPS coordination conference call
	1330	Afternoon coordination call with LRD, LRN and OHRFC and Nashville WFO
	1400	Attended emergency operations center call with HQ UOC.
	1524	Water Management Update is issued discussing the record flooding and release schedule from Kentucky and Barkley Lakes
	1800	Barkley reaches steady discharge of 230,000 cfs
	1800	Nashville stage - 49.49
5-May	0	Nashville stage - 49.14
	600	Nashville stage - 48.75
	700	LRD exchanges data with TVA
	701	LRN WM observed data sent to NWS
	715	LRD exchanges data with LMRFC
	730	LRD exchanges data with LRN
	800	WFO Nashville morning data received by LRN WM

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Date	Time (CDT)	Event
5-May	0828	TN USGS sent LRN email asking if they needed the USGS to place a "Rapid Deployment Gage" at Kingston Springs.
	830	Conference call between LRN WM, LRD WM, and OHRFC to discuss present operating plan.
	1200	Nashville stage - 48.48
	1330	Conference call between LRN WM, LRD WM, and OHRFC to discuss present operating plan.
	1800	Nashville stage - 47.63
6-May	0	Nashville stage - 46.08
	600	Nashville stage - 43.53
	700	LRD exchanges data with TVA
	715	LRD exchanges data with LMRFC
	730	LRD exchanges data with LRN
	746	LRN WM observed data sent to NWS
	800	WFC Nashville morning data received by LRN WM
	830	Conference call between LRN WM, LRD WM, and OHRFC to discuss present operating plan.
	1200	Nashville stage - 40.6
	1330	Conference call between LRN WM, LRD WM, and OHRFC to discuss present operating plan.
	1431	LRN WM forecast data sent to NWS
	1800	Nashville stage - 37.92
7-May	0	Nashville stage - 35.73
	600	Nashville stage - 34.1
	700	LRD exchanges data with TVA

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Date	Time (CDT)	Event
7-May	715	LRD exchanges data with LMRFC
	730	LRD exchanges data with LRN
	731	LRN WM observed data sent to NWS
	800	WFC Nashville morning data received by LRN WM
	830	Conference call between LRN WM, LRD WM, and OHRFC to discuss present operating plan.
	1200	Nashville stage - 32.51
	1316	LRN WM forecast data sent to NWS
	1800	Nashville stage - 31.33
8-May	0	Nashville stage - 30.24
	600	Nashville stage - 29.43
	700	LRD exchanges data with TVA
	715	LRD exchanges data with LMRFC
	730	LRD exchanges data with LRN
	800	WFC Nashville morning data received by LRN WM
	830	Conference call between LRN WM, LRD WM, and OHRFC to discuss present operating plan.
	916	LRN WM observed data sent to NWS
	1200	Nashville stage - 28.48
	1316	LRN WM forecast data sent to NWS
	1800	Nashville stage - 27.80
	2400	Nashville stage - 27.45

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Appendix E – National Weather Service Timeline of Events

National Weather Service Timeline

(All times CDT)

Event timeline for the Ohio River Forecast Center (OHRFC) and the Nashville Weather Forecast Office (WFO). This timeline was provided by the OHRFC and NWFO.

- Apr. 26…Enhanced situational awareness began internal to OHRFC Monday
- Apr 27…WFO Nashville issued first Hazardous Weather Outlook that mentions heavy rain and strong storms
- Apr. 28…OHRFC issued CRWHMDTIR highlighting weekend flood threat
- Apr. 28…OHRFC sent email coordinating flood risk to Cumberland and Lower Ohio Valley for the weekend with CORPS LRD.
- Apr. 29…OHRFC issued CRWHMDTIR highlighting dramatically increasing flood threat for the weekend.
- Apr 29…WFO Nashville issued Hydrologic Outlook for potential heavy rain and flooding (a.m. and p.m.)
- Apr. 29…OHRFC participated in coordination via conference calls beginning Thursday with the CORPS Ohio Division (LRD). CORPS LRD was briefed to expect widespread 3-5 inches but could not rule out 9-10 inches some places.
- Apr. 29…OHRFC coordinated contingency forecast of near 400,000 cfs flows for lower Ohio Smithland 7-8 days out and possible 100,000-200,000 cfs outflows from lower Cumberland River near Clarksville to CORPS LRD.
- Apr. 29…OHRFC coordinated contingency forecast near 400,000 cfs flows to LMRFC for lower Ohio Smithland flows for 7-8 days out.
- Apr. 29…OHRFC sent coordinated email alert to Customer Advisory Board on fixing an issue with GFS MMEFS and risk of flooding to Kentucky and Tennessee. This included 19 partners such as FEMA Region IV, TEMA, and CORPS LRD.

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- Apr 30, 5am…WFO Nashville re-issues Hydrologic Outlook for potential heavy rain and flooding.
- Apr. 30…OHRFC issued CRWHMDTIR with a headline of flood threat. In addition, highlighted potential for moderate to major flood threat.
- Apr. 30, 10am…OHRFC issued Flood Potential Outlook product for at least 30% chance of moderate to major flood potential in Nashville.
- Apr. 30…OHRFC produced an operational 72-hour QPF. Issued 3-4 inches of QPF for Nashville and just upstream. Hydrometeorological Prediction Center (HPC) had 5 inches. Coordinated this to WFO Nashville.
- Apr. 30…OHRFC coordinated with partners via Hydrologic Alert Message. This alerted them to at least moderate flood potential in Kentucky and Tennessee. Partners included FEMA Region IV, USGS all offices, USGS national flood coordinator, WFOs, Lower Mississippi RFC, TEMA.
- Apr 30, 130pm…WFO Nashville sent e-mail briefing to EMAs and TEMA
- Apr. 30, 330pm…WFO Nashville issued Flash Flood Watch for Saturday morning thru Monday morning (Sunday focus)
- May 1…OHRFC 24-hour operations began.
- May 1…OHRFC issued 48-hour QPF – one of the biggest non-tropical QPF known to be issued by OHRFC. OHRFC issued over 6 inches in Nashville area. This was coordinated with WFOs.
- May 1, 8am…WFO Nashville updated Flash Flood Watch to 2-4 inches with locally 8 inches
- May 1, 8am…OHRFC sent urgent e-mail about the SREF MMEFS to WFOs including Nashville and CORPS LRD as follows. (WFOs and CORPS LRD have access to all MMEFS products):
- "Please take the attached results very seriously. The model trends have been consistent. We are looking at a significant potential for Major Flooding. The OHRFC will be staffed 24-hrs from now through Monday morning, with increased weekend day and evening staffing as well."
- May 1, 830am…OHRFC participated in conference call with CORPS led by CORPS LRD
- May 1, 950am…WFO Nashville issued Flood Advisory for Metro Nashville and most neighboring counties specifically addressing Mill Creek and Whites Creek
- May 1, 1102am…WFO Nashville issued Flood Watch for rivers
- May 1, 1145am…Flash Flood Watch updated to 4-6 inches, locally 12 inches

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- May 1, 1239pm…WFO Nashville issued first Flood Warning for Mill Creek
- May 1, 1pm…OHRFC coordinated with partners via Hydrologic Alert Message. Upgraded threat to major flooding in parts of Tennessee and Kentucky. Sent to FEMA Region IV, TEMA, USGS, CORPS and 167 partners e-mail addresses
- May 1, 230pm…WFO Nashville conducted update webinar via GoToMeeting for EMAs and TEMA
- May 1, Approx. 315pm…WFO Nashville issued Flood Warning for most rivers in west and northwest Middle TN plus Areal Flood Warning for much of mid-state (valid 24 hours)
- May 1, 343pm…WFO Nashville upgraded Mill Creek Flood Warning to moderate flooding (major flooding now forecast)
- May 1, 547pm…WFO Nashville issued Civil Emergency Message at request of Nashville OEM to urge Davidson County citizens to stay off roads
- May 1, 630pm…WFO Nashville briefed OEM and Mayor on potential for much more rain on Sunday
- May 1, 640pm…WFO Nashville re-issued Civil Emergency Message to urge drivers to stay off roads
- May 1, 7:45pm…WFO Nashville briefed OEM regarding break in the rain overnight
- May 1, 9pm…OHRFC coordinated with partners via Hydrologic Alert Message. Upgraded threat to major and record flood risk in Tennessee and Kentucky at 10 pm. Sent to the FEMA Region IV 24-hour watch center, TEMA, USGS, CORPS and 167 partner e-mail addresses.
- May 1, 10pm…OHRFC unsuccessfully tried to contact CORPS Nashville to get updated flow forecast.
- May 1, 1157pm…WFO Nashville re-issued Civil Emergency Message to discourage drivers
- May 2, Midnight…OHRFC called WFO Nashville and told them Nashville would probably make flood stage.
- May 2, 3am…OHRFC issued forecast for Nashville just below flood stage. Based on estimated model simulations, with no input available from CORPS releases.
- May 2, 416am…CORPS Great Lakes and Ohio Division relayed an e-mail to OHRFC from CORPS Nashville originally issued at 808pm Saturday night (5/1) stating CORPS Nashville will try and hold 40-42 feet at Nashville based on CORPS Nashville model runs (e-mail not read until 7 am).
- May 2, 5am…OHRFC held internal discussion on Nashville. Midnight shift told day shift it was imperative to get a hold of CORPS Nashville. Model runs with no QPF produced

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40 feet (flood stage) at Nashville, with 54 feet modeled using full QPF and ignoring CORPS reservoir release forecasts.

- May 2, OHRFC tried unsuccessfully to call CORPS Nashville before 6 am and again shortly after 6 am. Contacted CORPS LRD to see how we can contact them. We were told they will be in around 715 am CDT.
- May 2, 636am…WFO Nashville issued Flood Advisory for Cumberland River at Nashville
- May 2, approx. 715am…WFO Nashville coordinated with OHRFC and USGS about gage outage
- May 2, 812am…WFO Nashville coordinated with OHRFC
- May 2, 830am…WFO Nashville sent e-mail briefing to all EMAs and TEMA
- May 2, OHRFC coordinated with CORPS Ohio Division and Nashville and WFOs via phone/conference calls
- May 2, during first conference call at 830am, CORPS Nashville asked OHRFC for QPF. OHRFC said at least 3-4 inches of rain Nashville and east (upstream). OHRFC informed CORPS Nashville that OHRFC forecast would be dependent on CORPS release forecast. Coordinated 41.9 feet forecast with WFO Nashville.
- May 2, 930am…WFO Nashville briefed OEM and Mayor's Office
- May 2, 950am…WFO Nashville issued first Flood Warning for Cumberland River at Nashville (42 foot crest this eve)
- May 2, 1008am…WFO Nashville coordinated with USGS about gage outages
- May 2, 1042am…WFO Nashville issued Civil Emergency Message for West/Middle TN based on request by TEMA
- May 2, 1043am…WFO Nashville coordinated with OHRFC
- May 2, 1118am…WFO Nashville updated Flood Warning for Cumberland River at Nashville (possible major flooding at 45 feet tonight)
- May 2, 1125am…WFO Nashville issued Flood Warning for Metro creeks
- May 2, 1145am…WFO Nashville coordinated with OHRFC
- May 2, 1157am…WFO Nashville issued Civil Emergency Message for Hickman County at request of County Mayor (drivers, shelters, communication outage)
- May 2, 130pm…CORPS LRD and CORPS Nashville coordination call. CORPS reports 124,000 cfs out of Old Hickory and could go to 130,000-140,000 cfs. This was used to issue 337pm update of 48 feet after midnight or 3 feet above major flood stage at Nashville.

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- May 2, 130pm…LRD WM called the NWS OHRFC Hydrologist to inform them of the Kentucky and Barkley release schedules and asked them to coordinate with the Paducah Weather Forecast Office to issue the necessary warnings. The NWS OHRFC asked LRD WM to call the Paducah WFO Service Hydrologist directly to apprise them of Lake Barkley's release schedule to ensure the information was correctly conveyed. LRD WM called the Paducah WFO and communicated the release schedule and the expected rapidly changing conditions below the dam. LRD WM requested that the Paducah WFO issue the appropriate public advisories and warnings.
- May 2, 419pm…WFO Nashville updated Flood Warning for Cumberland River at Nashville
- May 2, 436pm…WFO Nashville relayed Nashville forecast to OEM
- May 2, 443pm…WFO Nashville relayed Nashville forecast to CORPS. CORPS now fairly confident they can hold at 150,000 cfs.
- May 2, 510pm…WFO Nashville coordinated with OEM
- May 2, 527pm…WFO Nashville issued Areal Flood Warning for most of Middle TN for 24 hours
- May 2, 628pm…WFO Nashville issued Flood Statement... Cumberland River at Nashville now at 46 feet (forecast 48 feet after midnight)
- May 2, 739pm…OEM calls WFO Nashville asking about 2-3 foot rise in Cumberland River
- May 2, 743pm…WFO Nashville called CORPS
- May 2, 746pm…WFO Nashville coordinated with OHRFC
- May 2, 750pm…CORPS returns call; states that Percy Priest increased from 5,000 cfs to 10,000 cfs; cuts anticipated at Old Hickory Dam but flow is currently 150,000 cfs

- May 2, 628pm…WFO Nashville issued Flood Statement... Cumberland River at Nashville now at 46 feet (forecast 48 feet after midnight)
- May 2, 739pm…OEM calls WFO Nashville asking about 2-3 foot rise in Cumberland River
- May 2, 743pm…WFO Nashville called CORPS
- May 2, 746pm…WFO Nashville coordinated with OHRFC
- May 2, 750pm…CORPS returns call; states that Percy Priest increased from 5,000 cfs to 10,000 cfs; cuts anticipated at Old Hickory Dam but flow is currently 150,000 cfs

- May 2, 800pm…WFO Nashville passed CORPS info to OEM

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- May 2, 804pm…WFO Nashville informed OHRFC of call they had with CORPS Nashville that Percy Priest went from 5,000 cfs to 10,000 cfs for about an hour but would cut back to 0 cfs at 9 pm. OHRFC asked about Old Hickory and what information WFO Nashville had. WFO Nashville said Old Hickory now at 150,000 cfs.
- May 2, At 926 pm…OHRFC issued 50.3 feet for Nashville based on information relayed from WFO Nashville.
- May 2, 1000pm…WFO Nashville issued Flood Statement... Cumberland River at Nashville now at 48 feet and heading for 50.3 feet early May 3 afternoon
- May 2, 1047pm…OHRFC looked at situation in Cumberland and prioritized forecasts at Clarksville, Carthage, and Nashville. Updated Clarksville to around 57 feet. Model generated 44.5 feet at Kingston Springs and issued this too. Coordinated this with WFO Nashville.
- May 2, just before 11pm…OHRFC called WFO Nashville. WFO Nashville did not have any updates from CORPS Nashville. WFO Nashville did say sand-bagging not working in Nashville.
- May 2, around 11pm…OHRFC called CORPS Nashville and told them situation has gone from bad to very serious. Needed flow forecasts for projects so OHRFC can put out the best forecast. OHRFC asked what Old Hickory was doing. CORPS Nashville stated Old Hickory went to 220,000 cfs but that was a ballpark number as they were above the gate ratings. Use as an estimate. Said they will get back with us shortly.
- May 3, 1200am…CORPS Nashville called the OHRFC and reported that they were having trouble contacting Old Hickory and would call back shortly.
- May 3, 1220am…CORPS Nashville called OHRFC back. Cordell Hull opened up to 90,000 cfs. Confirmed that Old Hickory was at approximately 220,000 cfs going down to no lower than 175,000 cfs and being lowered by 5,000 cfs per hour.
- May 3, 1am…OHRFC updated Carthage to 43 feet from 39 feet. Coordinated with WFO Nashville.
- May 3, 1am…OHRFC updated all processors and quality controlled rainfall for 1am operational run before doing Nashville forecast to get a final stage.
- May 3, 0130am…CORPS Nashville called the OHRFC and provided update on Old Hickory.
- May 3, 245am…OHRFC coordinated with WFO Nashville on 51.5 feet at Nashville. (Crested 14 hours later at 51.86 feet).
- May 3, 300am…OHRFC issued 51.5 feet for Nashville based on latest flow forecasts.
- May 3, 402am…WFO Nashville issued Flood Statement... Cumberland River at Nashville now at 50.4 feet and heading for 51.5 feet early this afternoon

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- May 3, 649am…WFO Nashville coordinates with OHRFC
- May 3, 725am…WFO Nashville issued Flood Statement... Cumberland River at Nashville now at 50.7 feet and heading for 51.5 feet early this afternoon
- May 3, 830am…OHRFC participated in conference call with CORPS LRD and Nashville. Kept 51.5 feet.
- May 3, 9am…OHRFC coordinated with partners via Hydrologic Alert Message - major to record flooding alert sent.
- May 3, 920am…WFO Nashville coordinates with OHRFC
- May 3, 1030am…WFO Nashville conducts update webinar via GoToMeeting for EMAs and TEMA
- May 3, 1030am…OHRFC participated in conference call with WFO Nashville and TEMA
- May 3, 1101am…WFO Nashville briefs TEMA Regional Director about Cheatham Dam river levels
- May 3, 1230pm…OHRFC and WFO Nashville participated in conference call with CORPS Nashville and OEM
- May 3, 1240pm…WFO Nashville briefs TEMA Regional Director about Cheatham Dam river levels
- May 3, 130pm…OHRFC participated in conference call with CORPS LRD, CORPS Nashville, WFO Nashville.
- May 3. 145pm…OHRFC updated Nashville slightly to 52 feet by evening. Coordinated this with WFO Nashville.
- May 3, 145pm…OHRFC hosted conference call with City of Nashville OEM, Nashville Mayor's Office – Deputy Mayor, TEMA, WFO Nashville, and CORPS LRD. Told them NWS forecast crest for Nashville is 52 feet. Gave them the range of uncertainty of 51.5 to 52.5 feet but really thought 52 feet would hold. Actual crest was 51.86 feet.
- May 3, 230pm…OHRFC participated in coordination call with CORPS Nashville. Asked if there was anything else they could do with Percy Priest to hold the 52 feet at Nashville.
- May 3, 335pm...WFO Nashville issued Civil Emergency Message for TEMA (drivers, roadblocks, wastewater, drinking water concerns)
- May 3, 342pm…WFO Nashville issued Flood Statement... Cumberland River at Nashville now at 51.6 feet and heading for 52 feet this evening
- May 3, 630 pm…OHRFC participated in coordination call with CORPS Nashville. Nashville crested at 6pm.

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- May 3, 819pm…WFO Nashville coordinates with OHRFC
- May 3, 825pm…WFO Nashville coordinates with CORPS
- May 4, 700am…WFO Nashville issued Flood Statement... Cumberland River at Nashville crested last night, now at 50.5 feet and falling; will stay above flood stage until early Wednesday (May 5)
- May 4, 845am…OHRFC participated in conference call with CORPS LRD and Nashville. Also coordinated near 600,000 cfs out of lower Ohio River at Smithland.
- May 4, 1030am…OHRFC participated in conference call with Nashville Metro Water, Fire, Mayor's Office, OEM, TEMA and WFO Nashville. Stated our forecast based on NWS/CORPS coordination is for a slow fall below 48 feet Wednesday at Nashville and 40 feet Thursday. Contingent on CORPS release.
- May 4, 1pm…OHRFC issued another Hydrologic Alert Message updating major to record flooding downstream of Nashville.
- May 5…OHRFC participated in CORPS conference calls 830 am and 130 pm.
- May 6…OHRFC participated in CORPS conference calls 830 am and 130 pm.
- May 7…OHRFC participated in CORPS conference call 830 am
- May 8…OHRFC participated in CORPS conference call 830 am

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Appendix F – Project and Gage Plots, and Tables

Appendix includes:

- Basin map
- Project Headwater and Discharge Plots
- Project Tailwater Plots
- Damage Center Stage Plots
- Project Tables
- Damage Center Tables

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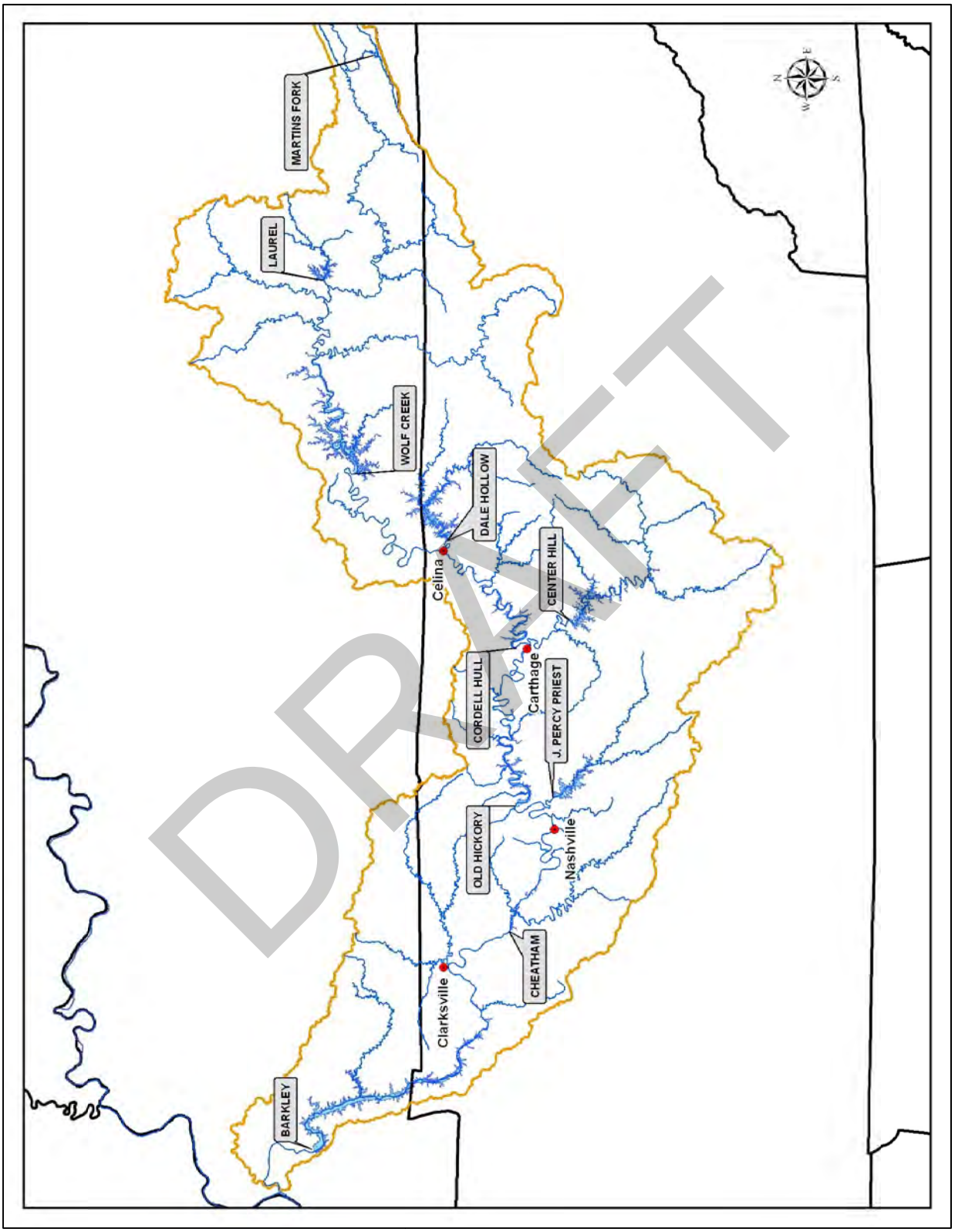
MARTINS FORK
LAUREL
WOLF CREEK
DALE HOLLOW
Celina
CENTER HILL
Carthage
CORDELL HULL
J. PERCY PRIEST
OLD HICKORY
Nashville
CHEATHAM
Clarksville
BARKLEY
N
E
S
W

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Project Headwater and Discharge Plots

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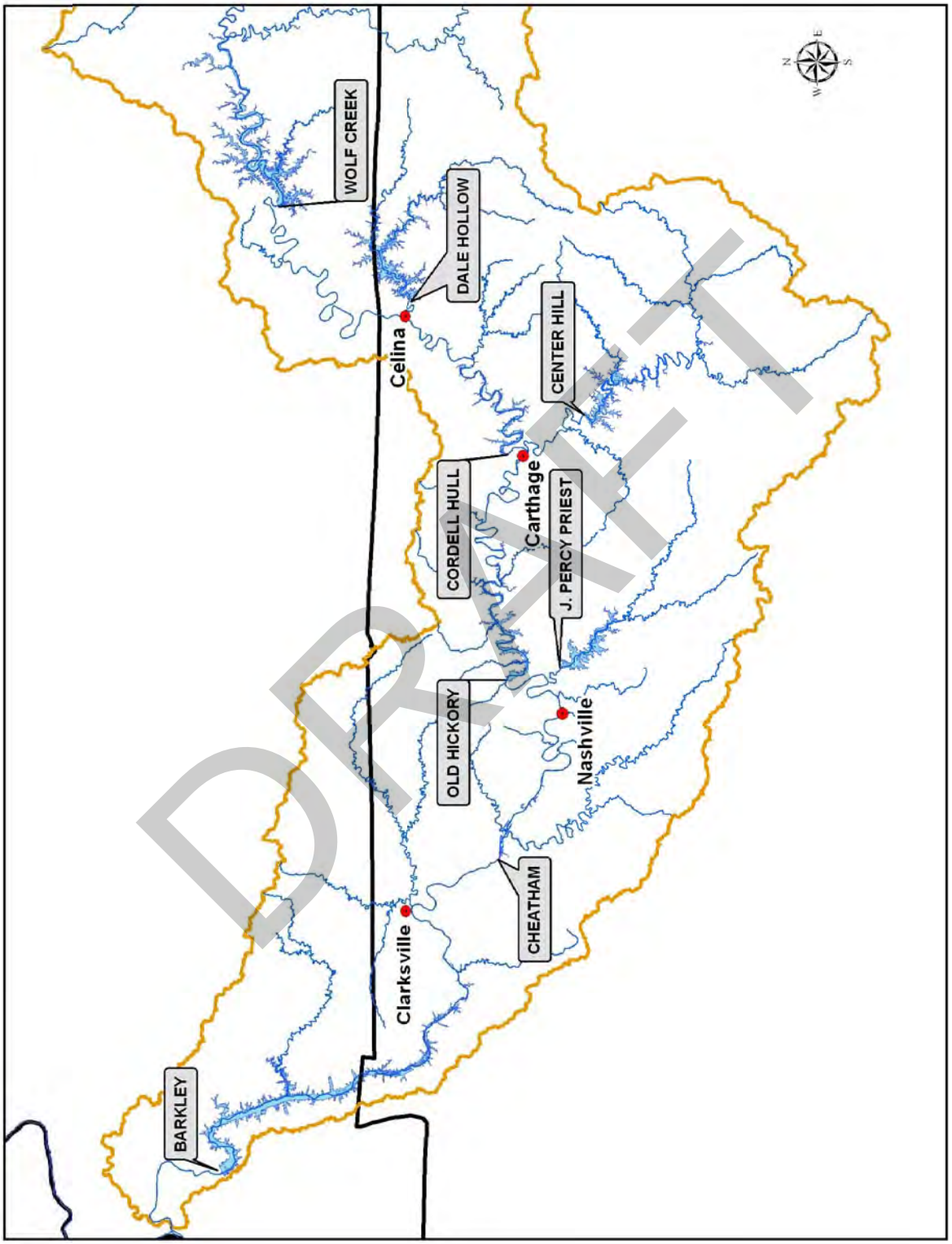
WOLF CREEK
DALE HOLLOW
Celina
CENTER HILL
Carthage
CORDELL HULL
J. PERCY PRIEST
OLD HICKORY
Nashville
CHEATHAM
Clarksville
BARKLEY
N
E
S
W
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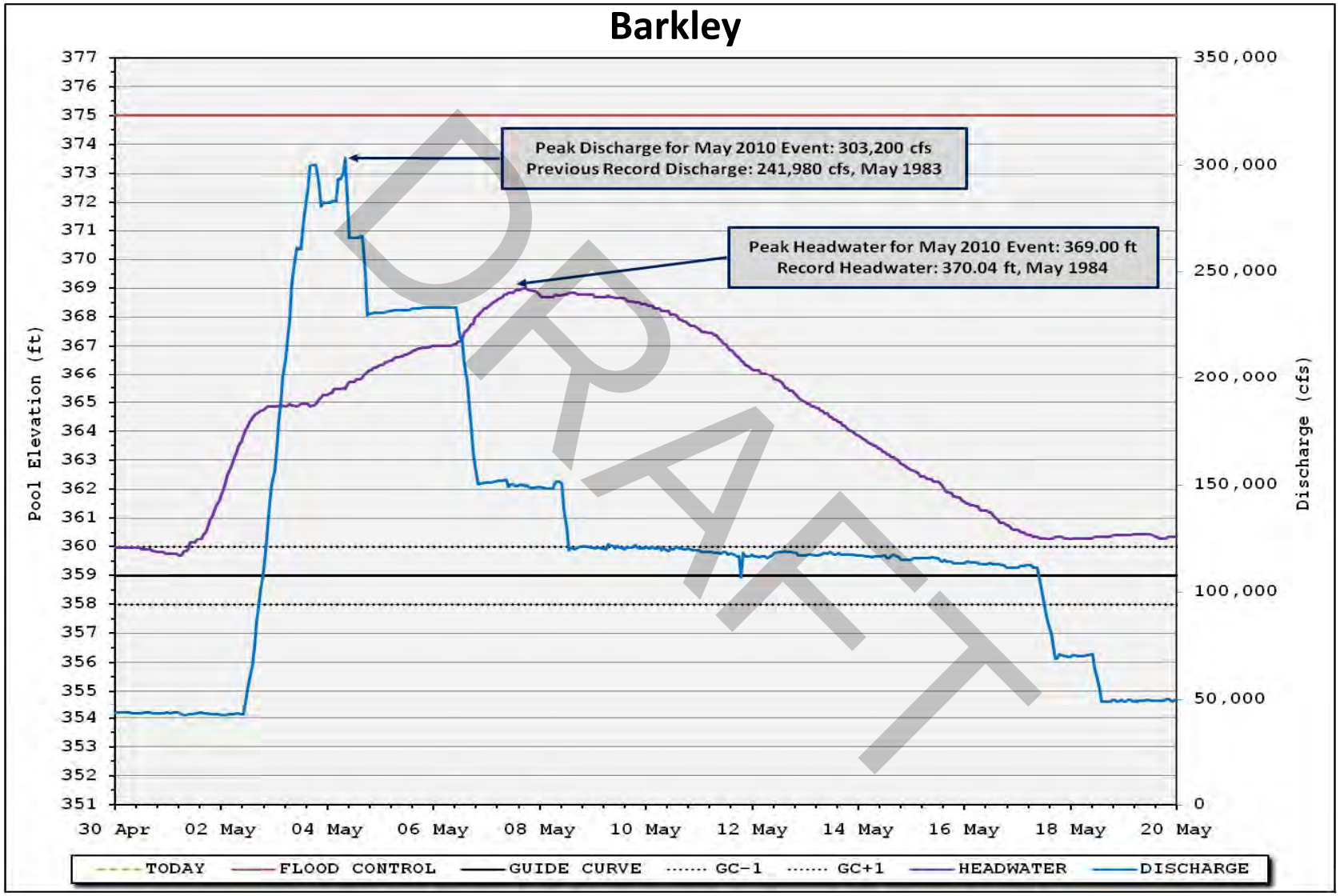
Barkley
Peak Discharge for May 2010 Event: 303,200 cfs
Previous Record Discharge: 241,980 cfs, May 1983
Peak Headwater for May 2010 Event: 369.00 ft
Record Headwater: 370.04 ft, May 1984
Pool Elevation (ft)
Discharge (cfs)
377
376
375
374
373
372
371
370
369
368
367
366
365
364
363
362
361
360
359
358
357
356
355
354
353
352
351
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
30 Apr
02 May
04 May
06 May
08 May
10 May
12 May
14 May
16 May
18 May
20 May
TODAY
FLOOD CONTROL
GUIDE CURVE
GC-1
GC+1
HEADWATER
DISCHARGE
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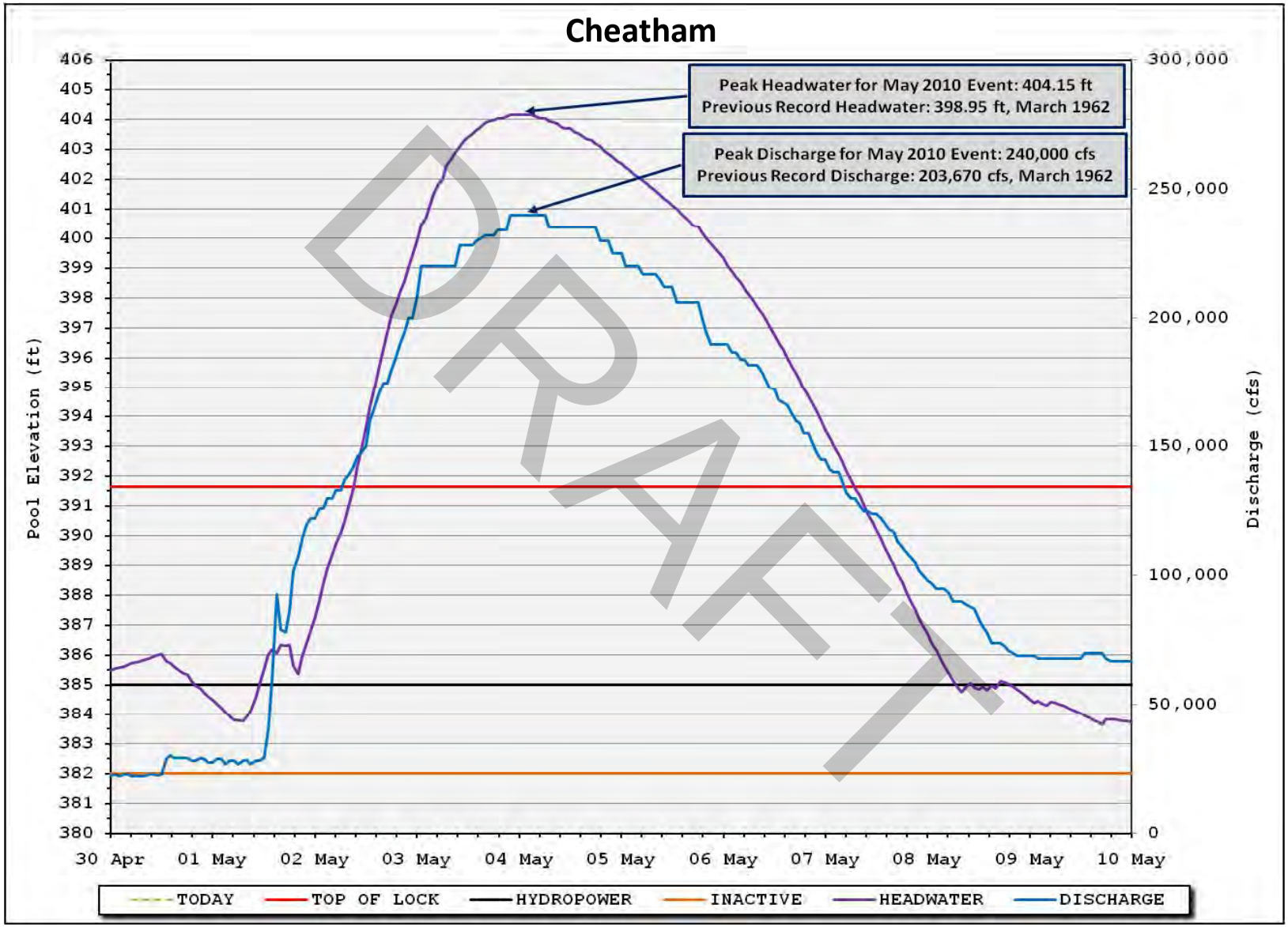
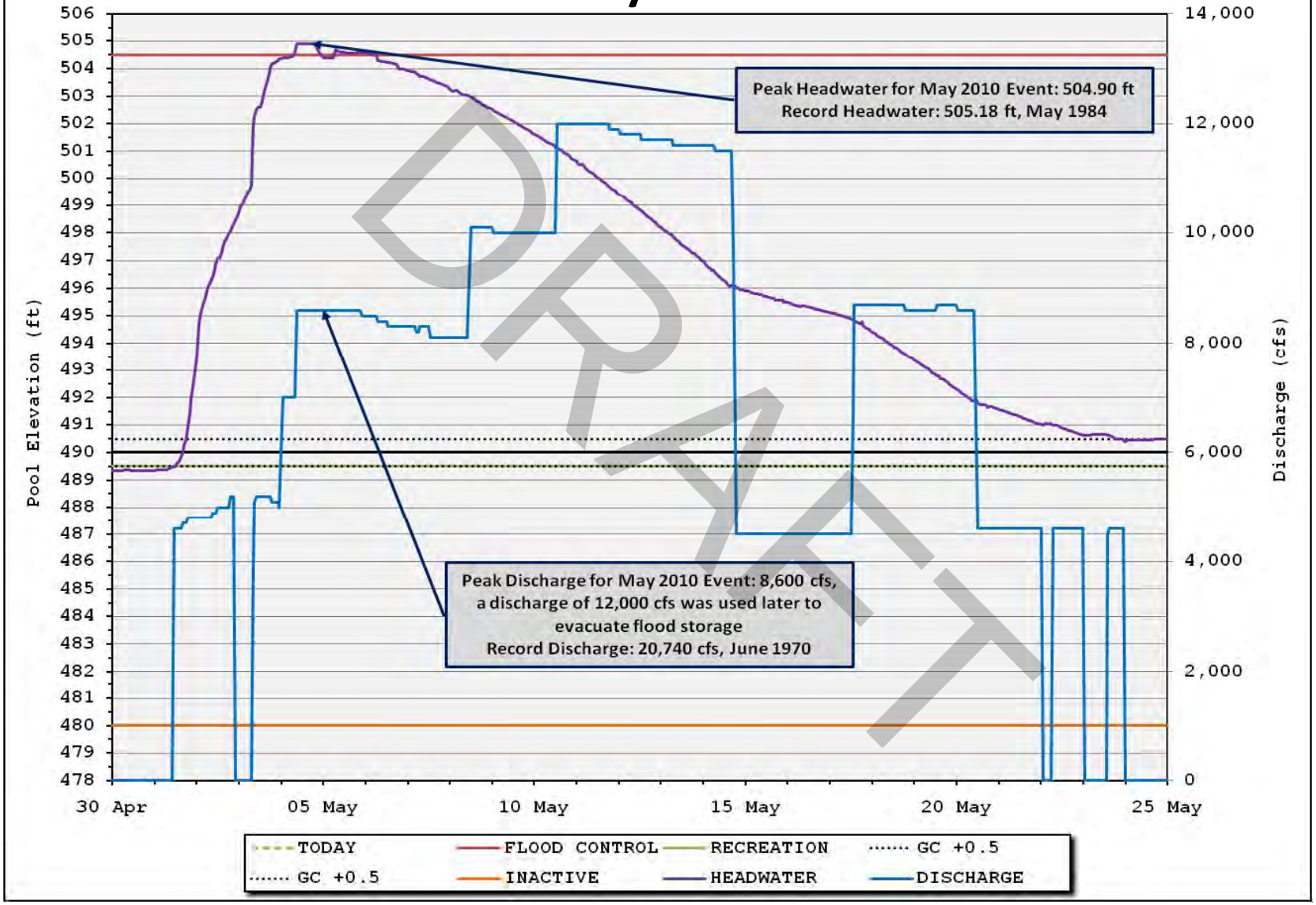

Cheatham
Peak Headwater for May 2010 Event: 404.15 ft
Previous Record Headwater: 398.95 ft, March 1962
Peak Discharge for May 2010 Event: 240,000 cfs
Previous Record Discharge: 203,670 cfs, March 1962
Pool Elevation (ft)
Discharge (cfs)
406
405
404
403
402
401
400
399
398
397
396
395
394
393
392
391
390
389
388
387
386
385
384
383
382
381
380
300,000
250,000
200,000
150,000
100,000
50,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
TODAY
TOP OF LOCK
HYDROPOWER
INACTIVE
HEADWATER
DISCHARGE
DRAFT

J. Percy Priest



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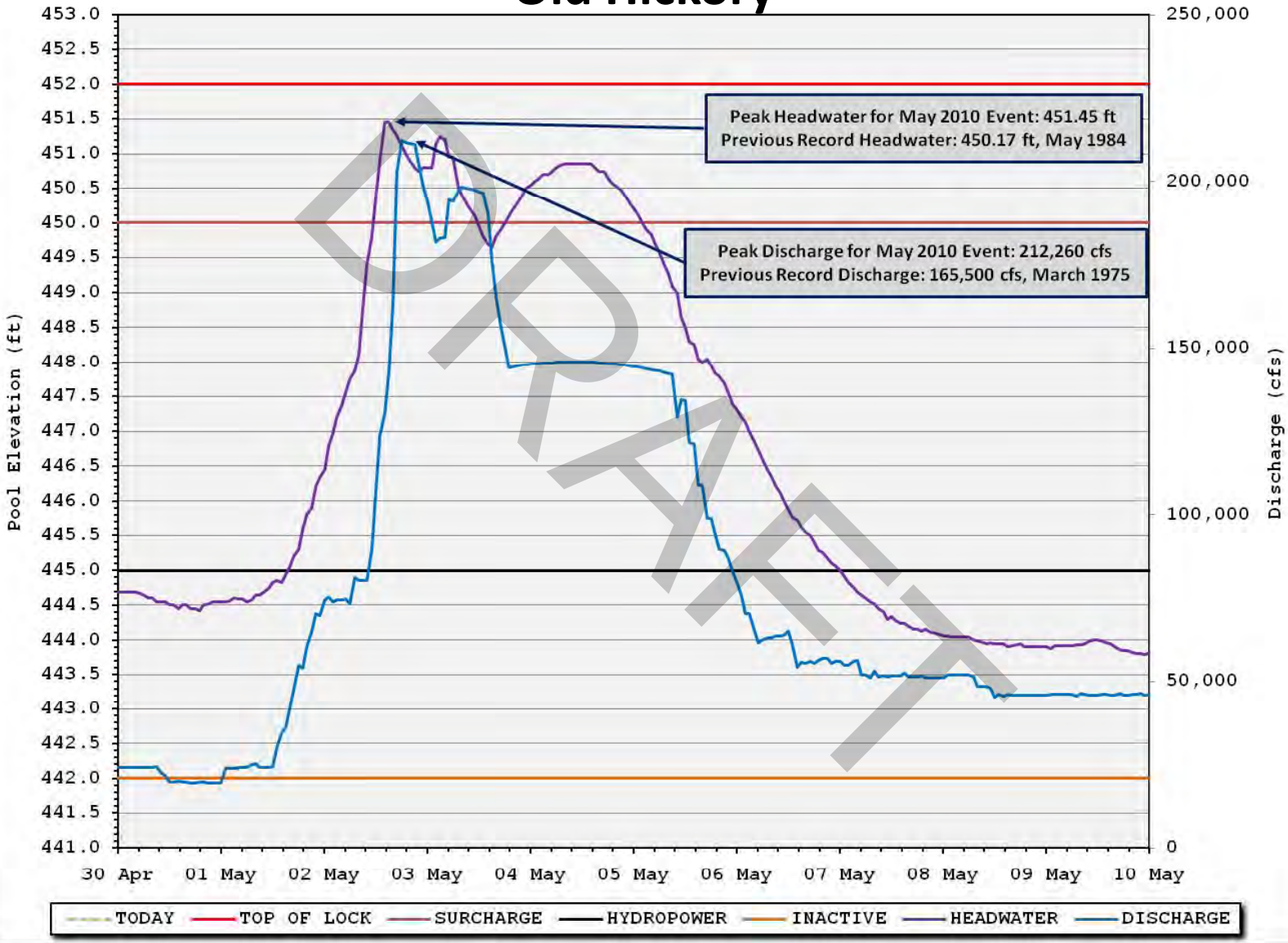
Old Hickory



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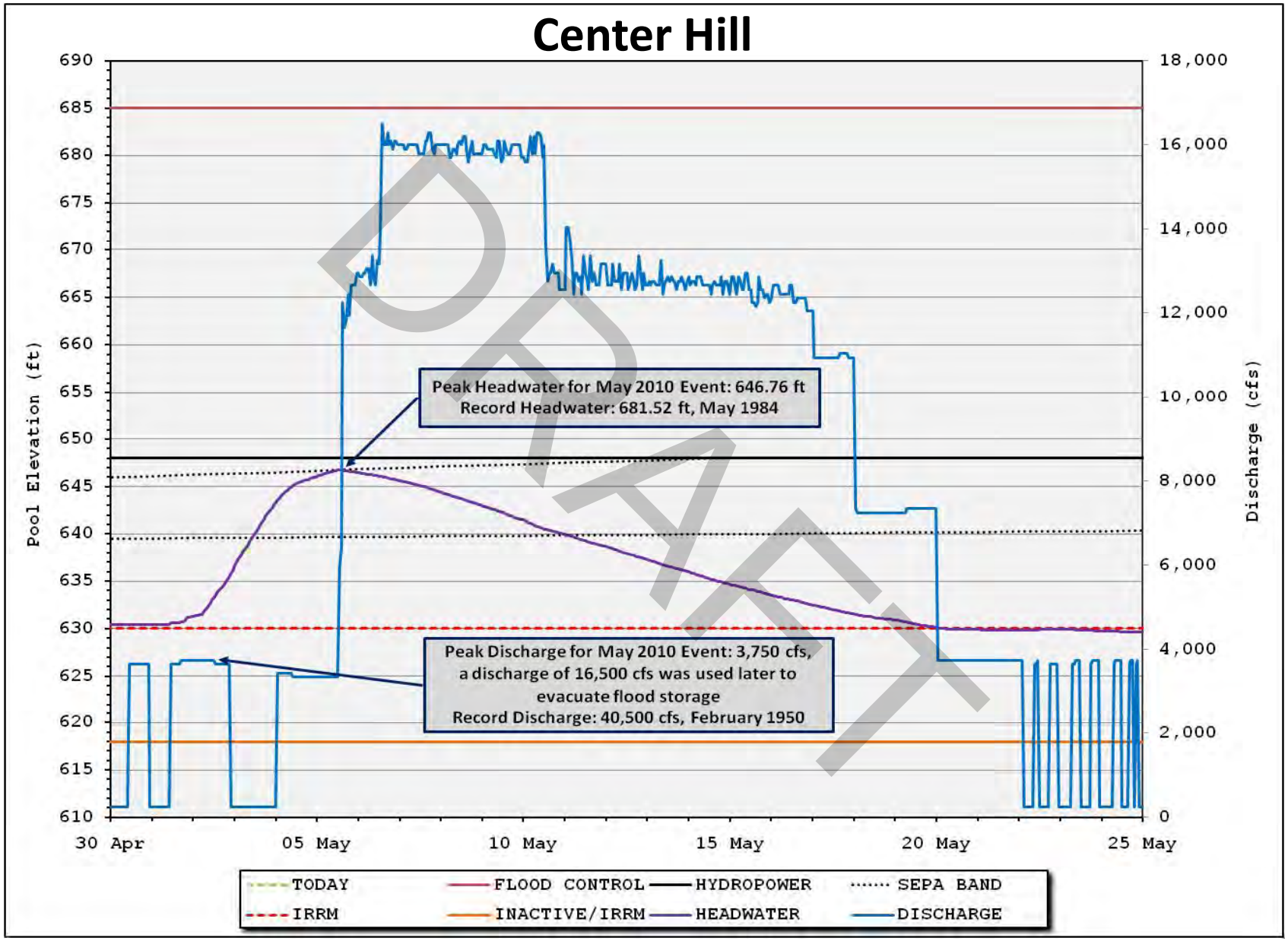
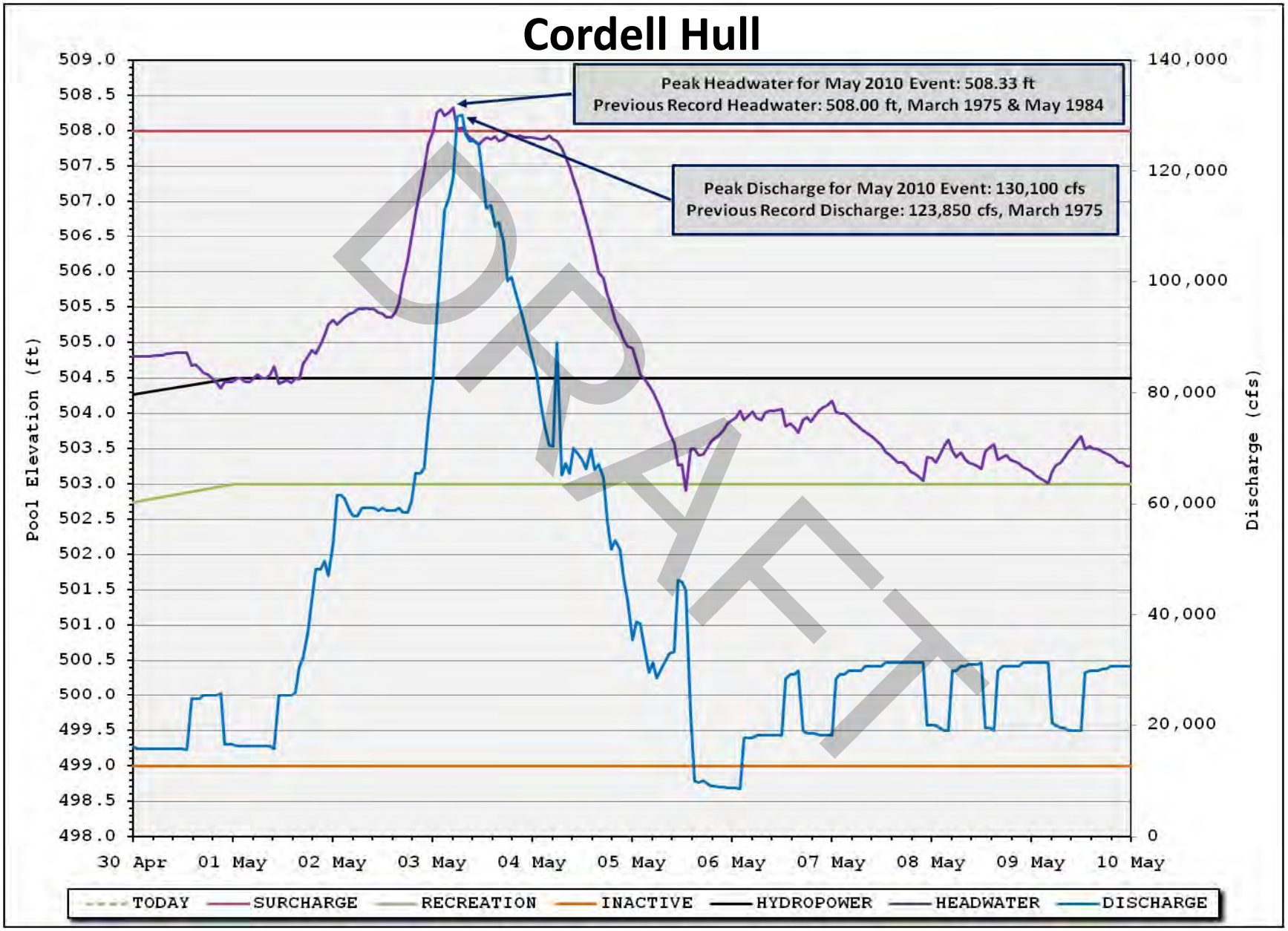

Center Hill
Pool Elevation (ft)
690
685
680
675
670
665
660
655
650
645
640
635
630
625
620
615
610
Discharge (cfs)
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
30 Apr
05 May
10 May
15 May
20 May
25 May
Peak Headwater for May 2010 Event: 646.76 ft
Record Headwater: 681.52 ft, May 1984
Peak Discharge for May 2010 Event: 3,750 cfs,
a discharge of 16,500 cfs was used later to
evacuate flood storage
Record Discharge: 40,500 cfs, February 1950
TODAY
FLOOD CONTROL
HYDROPOWER
SEPA BAND
IRRM
INACTIVE/IRRM
HEADWATER
DISCHARGE
DRAFT


Cordell Hull
Peak Headwater for May 2010 Event: 508.33 ft
Previous Record Headwater: 508.00 ft, March 1975 & May 1984
Peak Discharge for May 2010 Event: 130,100 cfs
Previous Record Discharge: 123,850 cfs, March 1975
Pool Elevation (ft)
Discharge (cfs)
509.0
508.5
508.0
507.5
507.0
506.5
506.0
505.5
505.0
504.5
504.0
503.5
503.0
502.5
502.0
501.5
501.0
500.5
500.0
499.5
499.0
498.5
498.0
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
TODAY
SURCHARGE
RECREATION
INACTIVE
HYDROPOWER
HEADWATER
DISCHARGE
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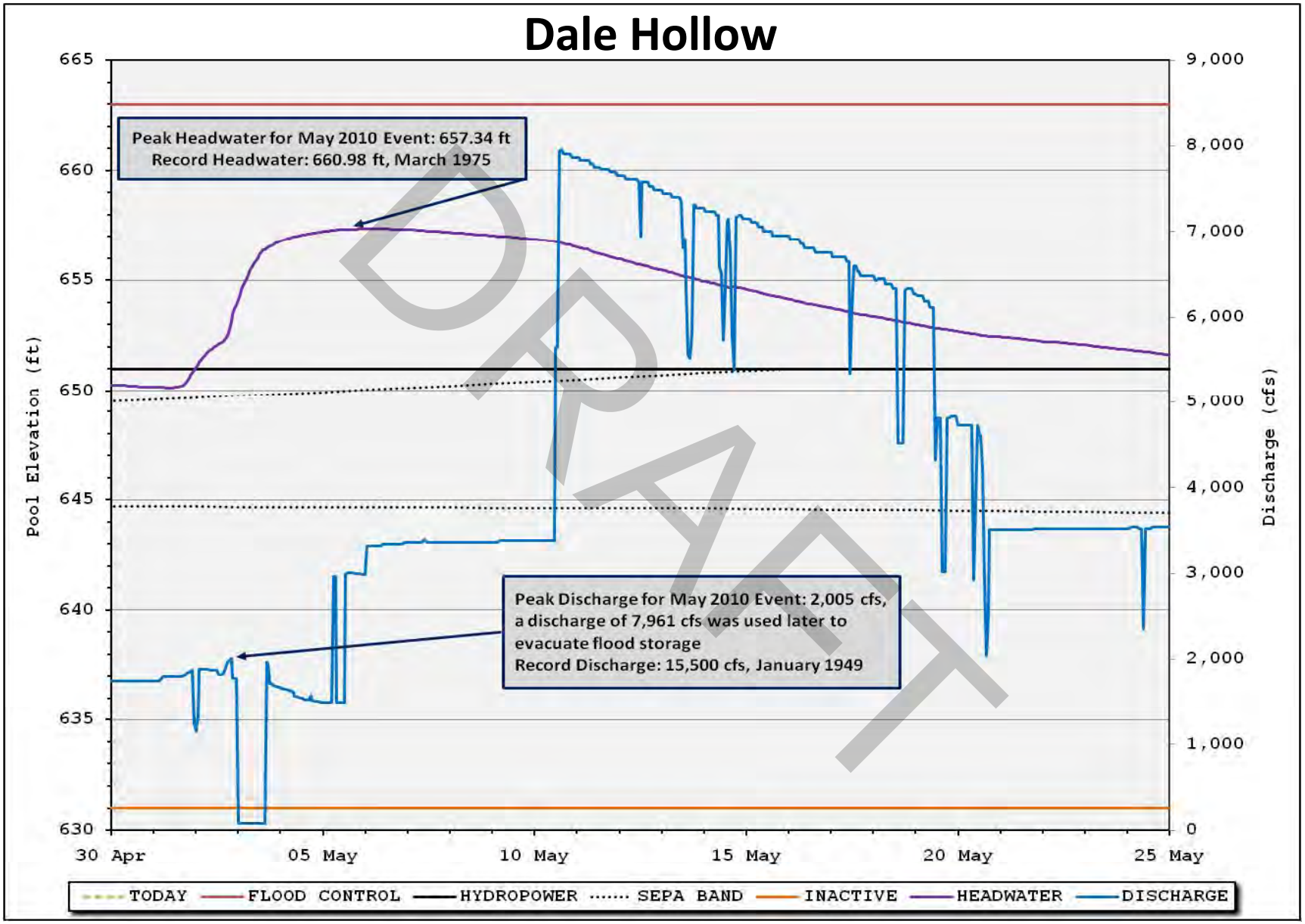
Dale Hollow



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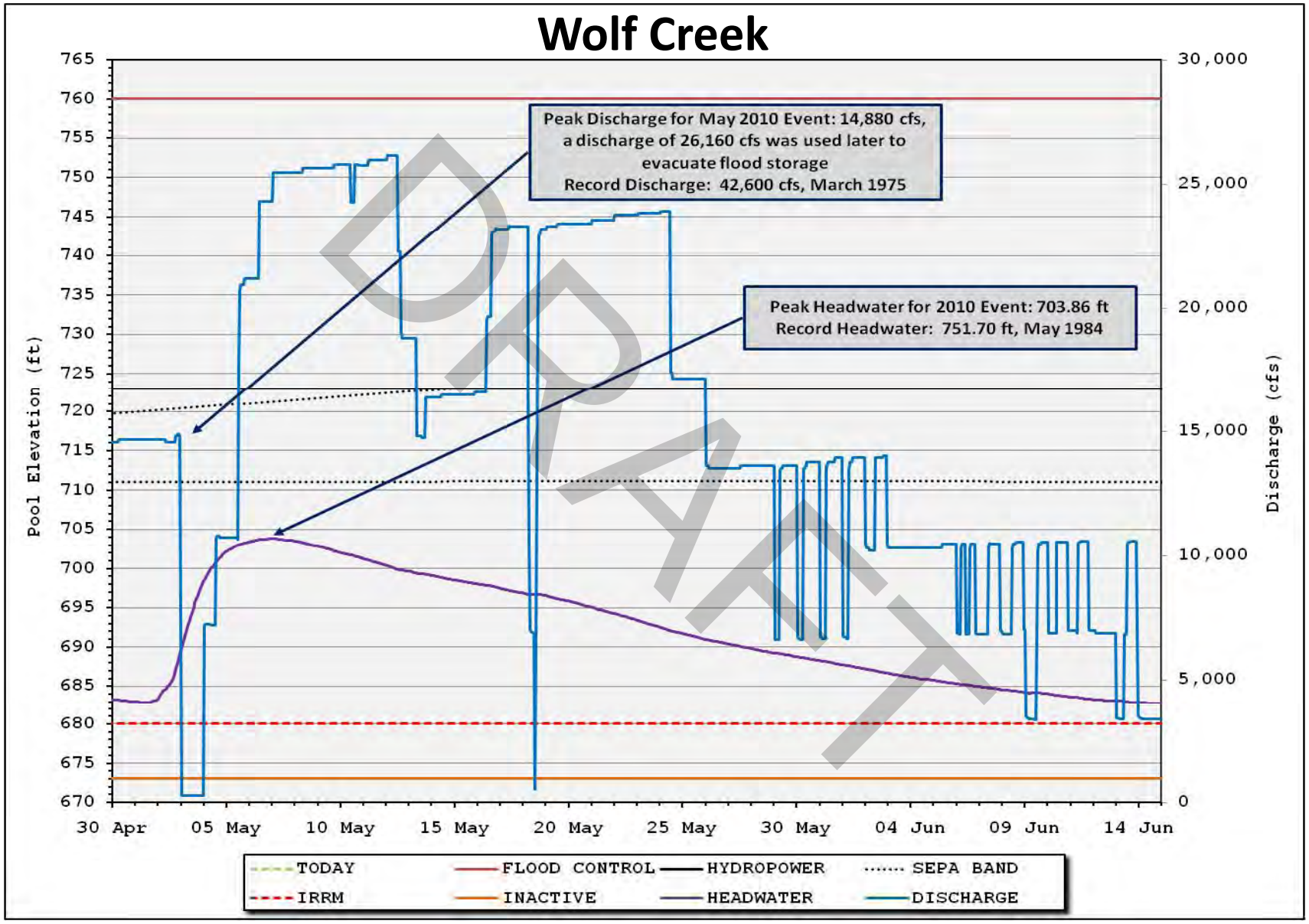
Wolf Creek
Peak Discharge for May 2010 Event: 14,880 cfs, a discharge of 26,160 cfs was used later to evacuate flood storage
Record Discharge: 42,600 cfs, March 1975
Peak Headwater for 2010 Event: 703.86 ft
Record Headwater: 751.70 ft, May 1984
Pool Elevation (ft)
Discharge (cfs)
765
760
755
750
745
740
735
730
725
720
715
710
705
700
695
690
685
680
675
670
30,000
25,000
20,000
15,000
10,000
5,000
0
30 Apr
05 May
10 May
15 May
20 May
25 May
30 May
04 Jun
09 Jun
14 Jun
TODAY
FLOOD CONTROL
HYDROPOWER
SEPA BAND
IRRM
INACTIVE
HEADWATER
DISCHARGE

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Project Tailwater Plots

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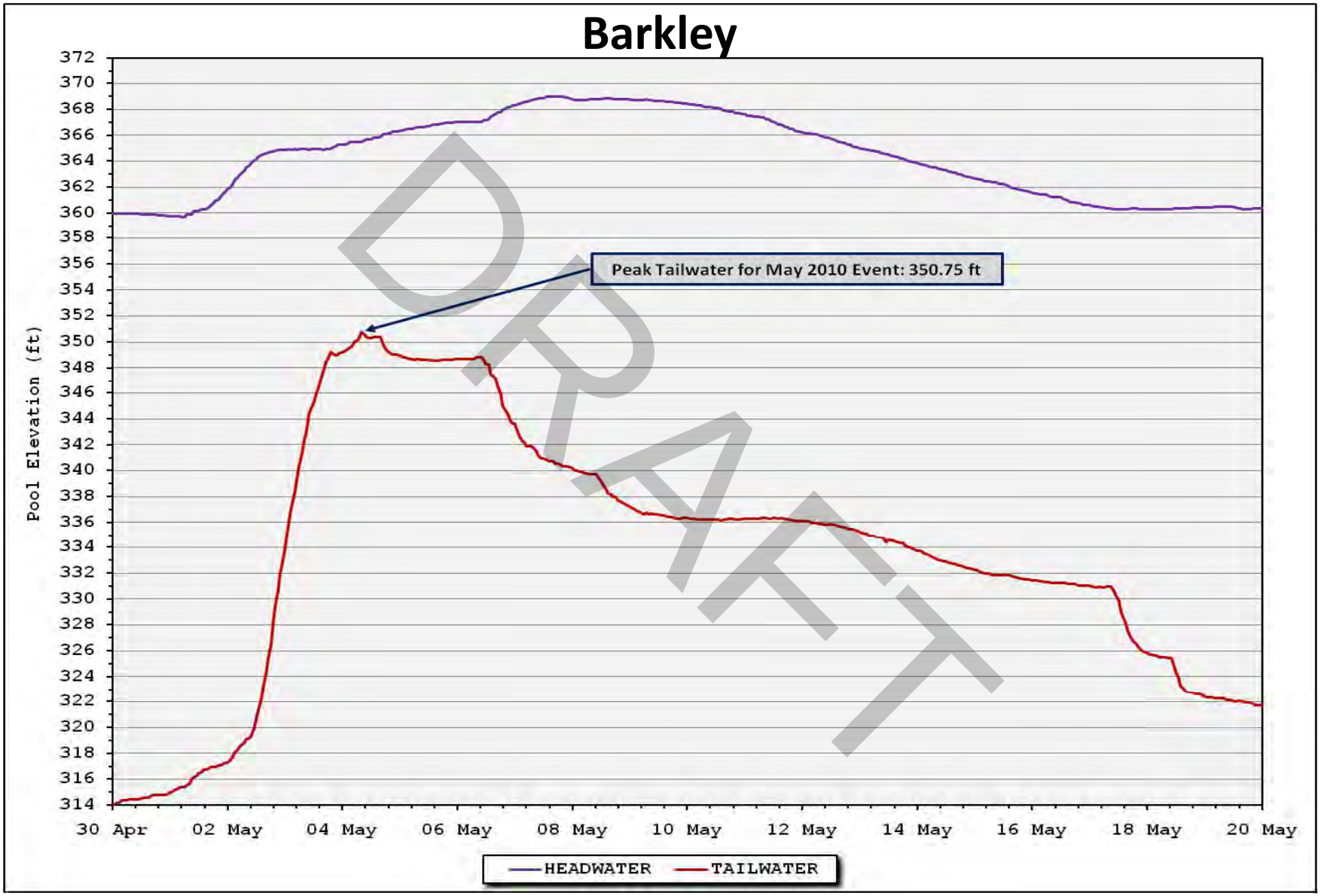
Barkley
Pool Elevation (ft)
372
370
368
366
364
362
360
358
356
354
352
350
348
346
344
342
340
338
336
334
332
330
328
326
324
322
320
318
316
314
30 Apr
02 May
04 May
06 May
08 May
10 May
12 May
14 May
16 May
18 May
20 May
Peak Tailwater for May 2010 Event: 350.75 ft
HEADWATER
TAILWATER
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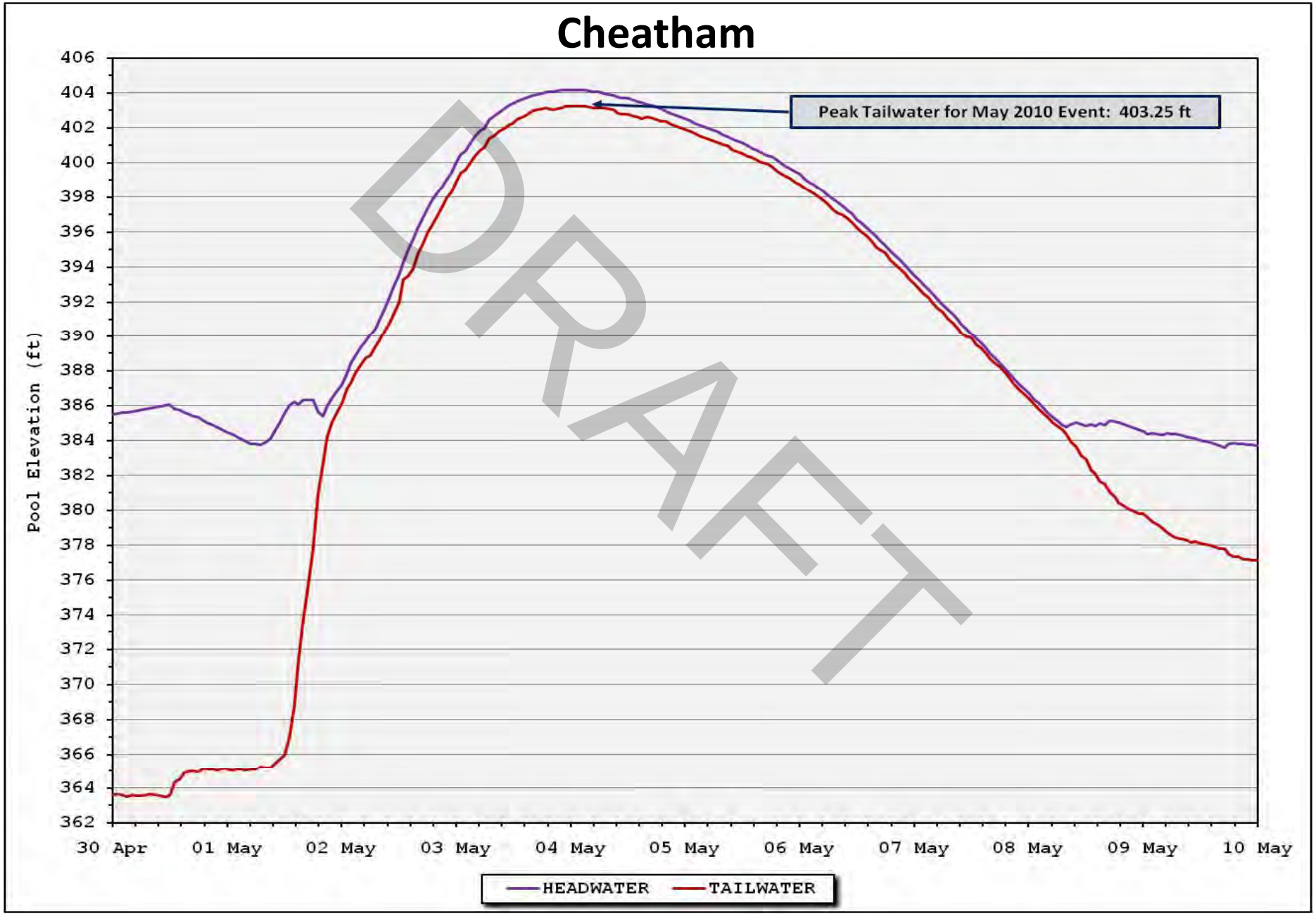
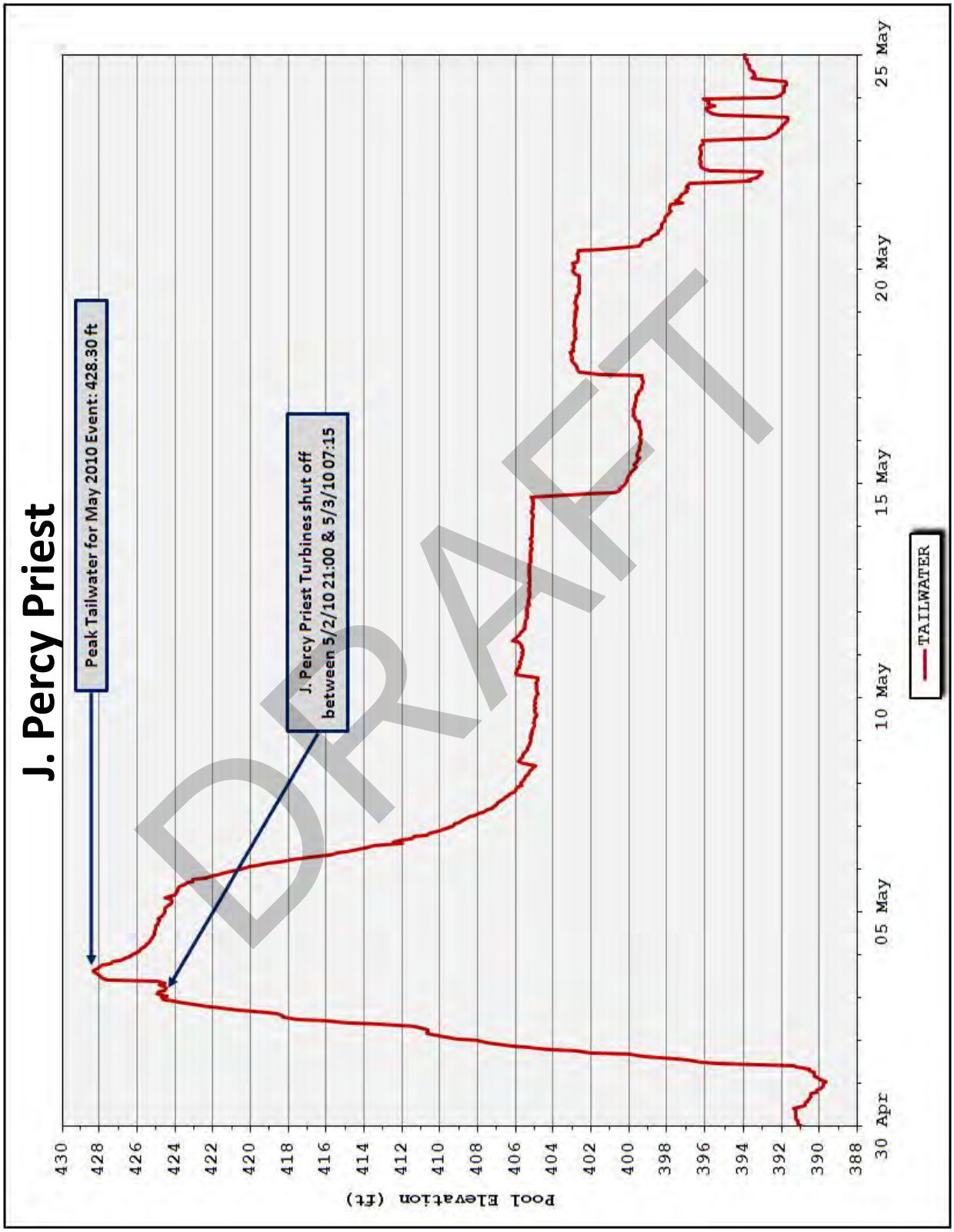
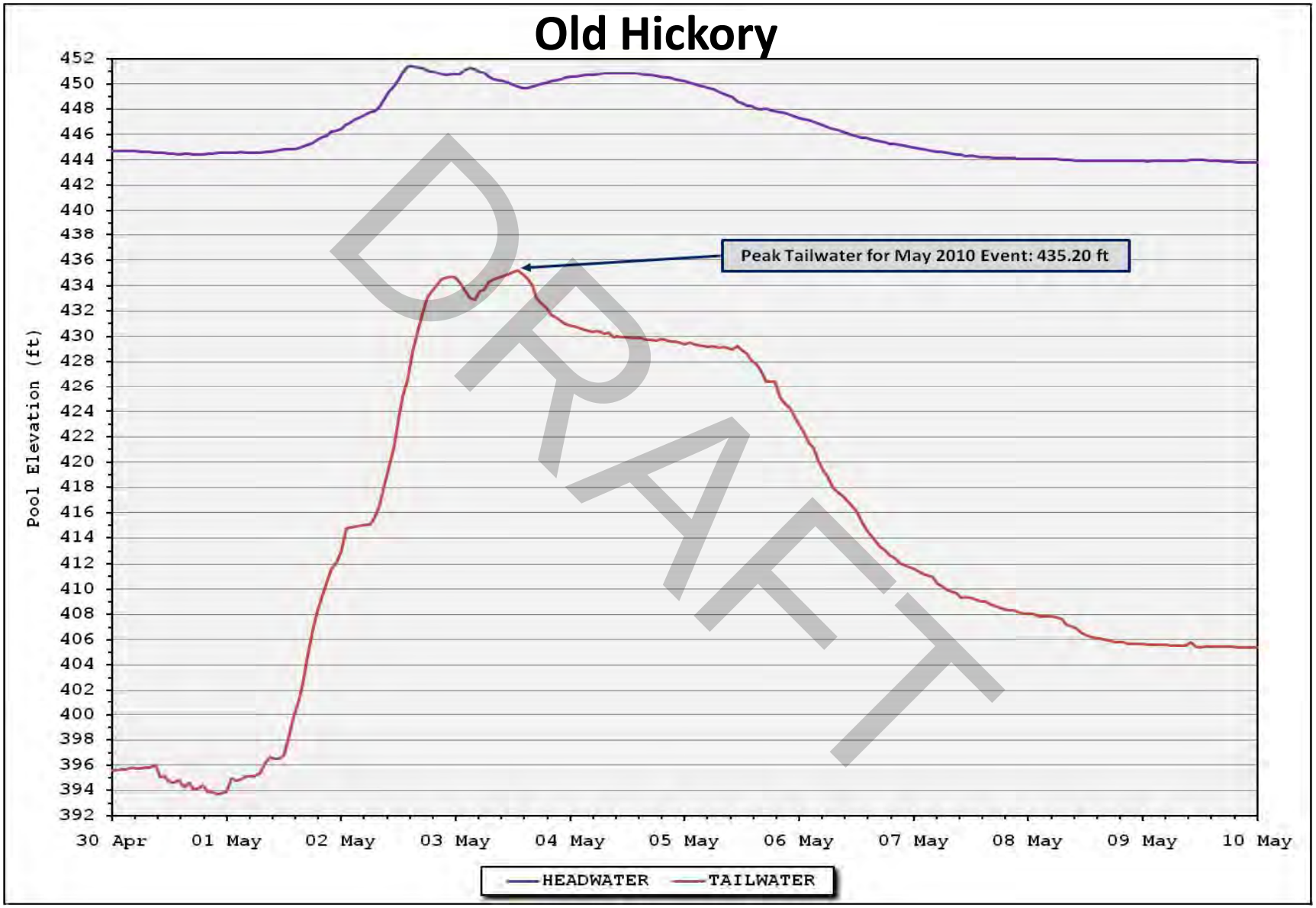
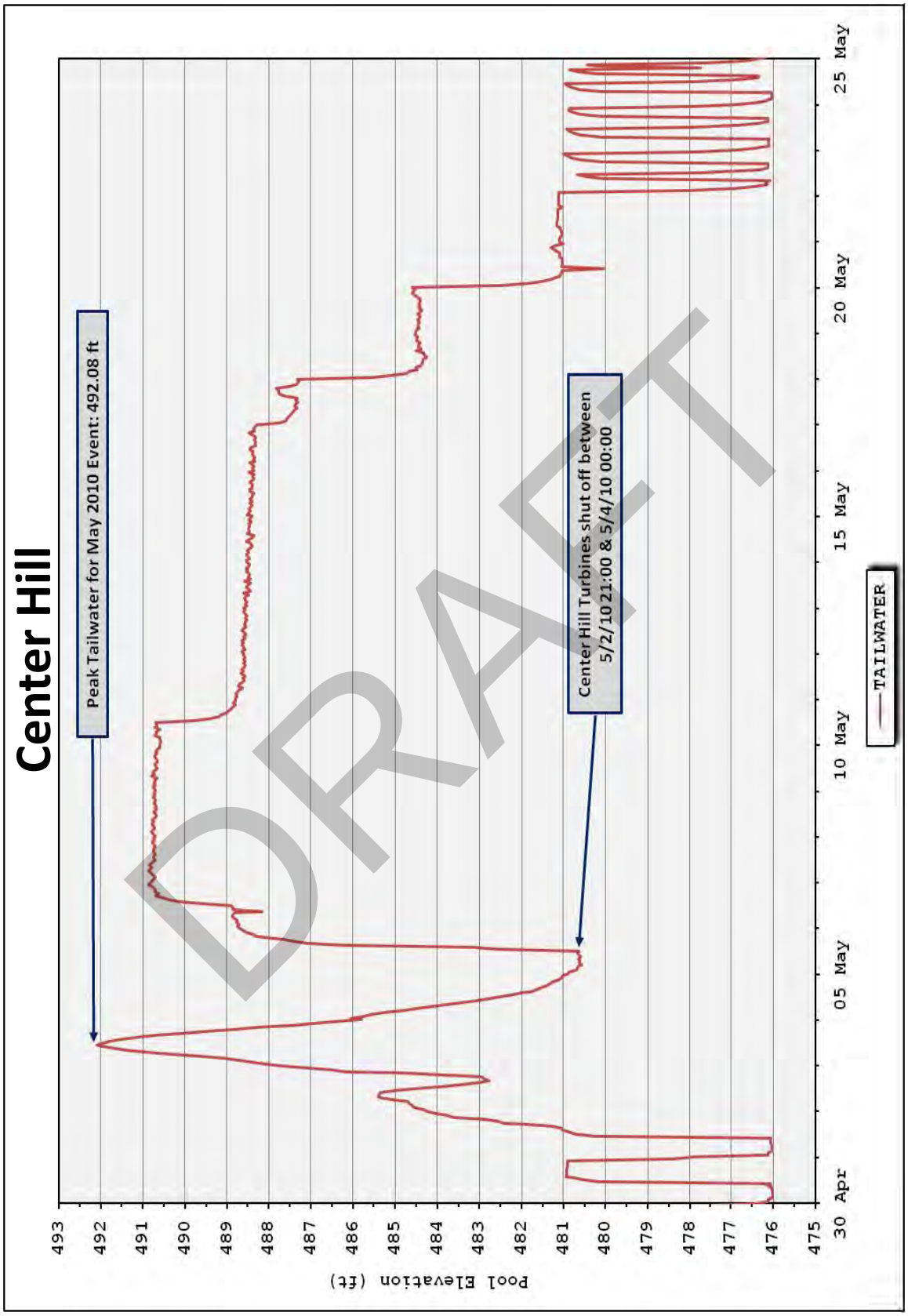

Cheatham
Peak Tailwater for May 2010 Event: 403.25 ft
Pool Elevation (ft)
406
404
402
400
398
396
394
392
390
388
386
384
382
380
378
376
374
372
370
368
366
364
362
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
HEADWATER
TAILWATER
DRAFT

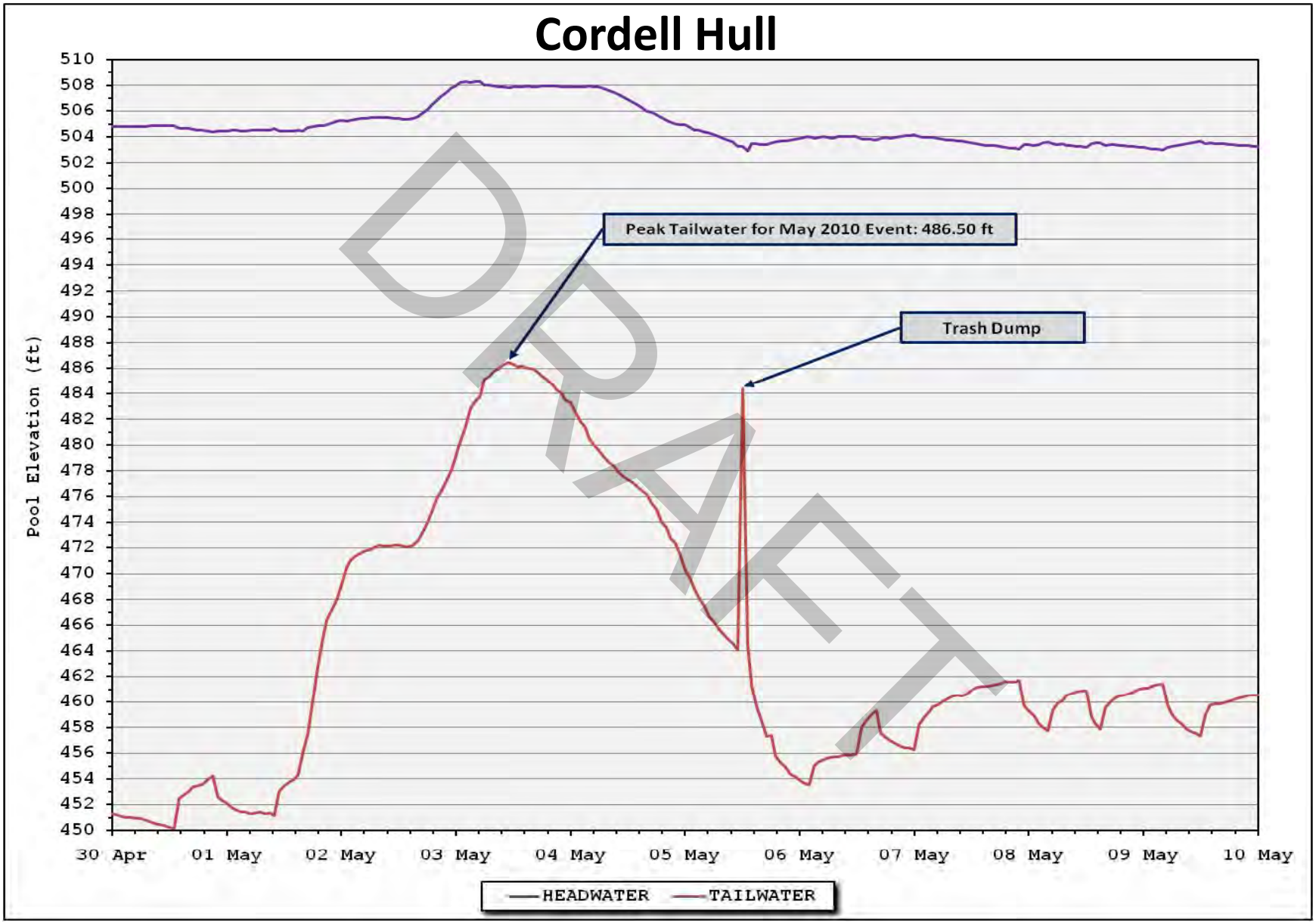

J. Percy Priest
Peak Tailwater for May 2010 Event: 428.30 ft
J. Percy Priest Turbines shut off between 5/2/10 21:00 & 5/3/10 07:15
Pool Elevation (ft)
430
428
426
424
422
420
418
416
414
412
410
408
406
404
402
400
398
396
394
392
390
388
30 Apr
05 May
10 May
15 May
20 May
25 May
TAILWATER

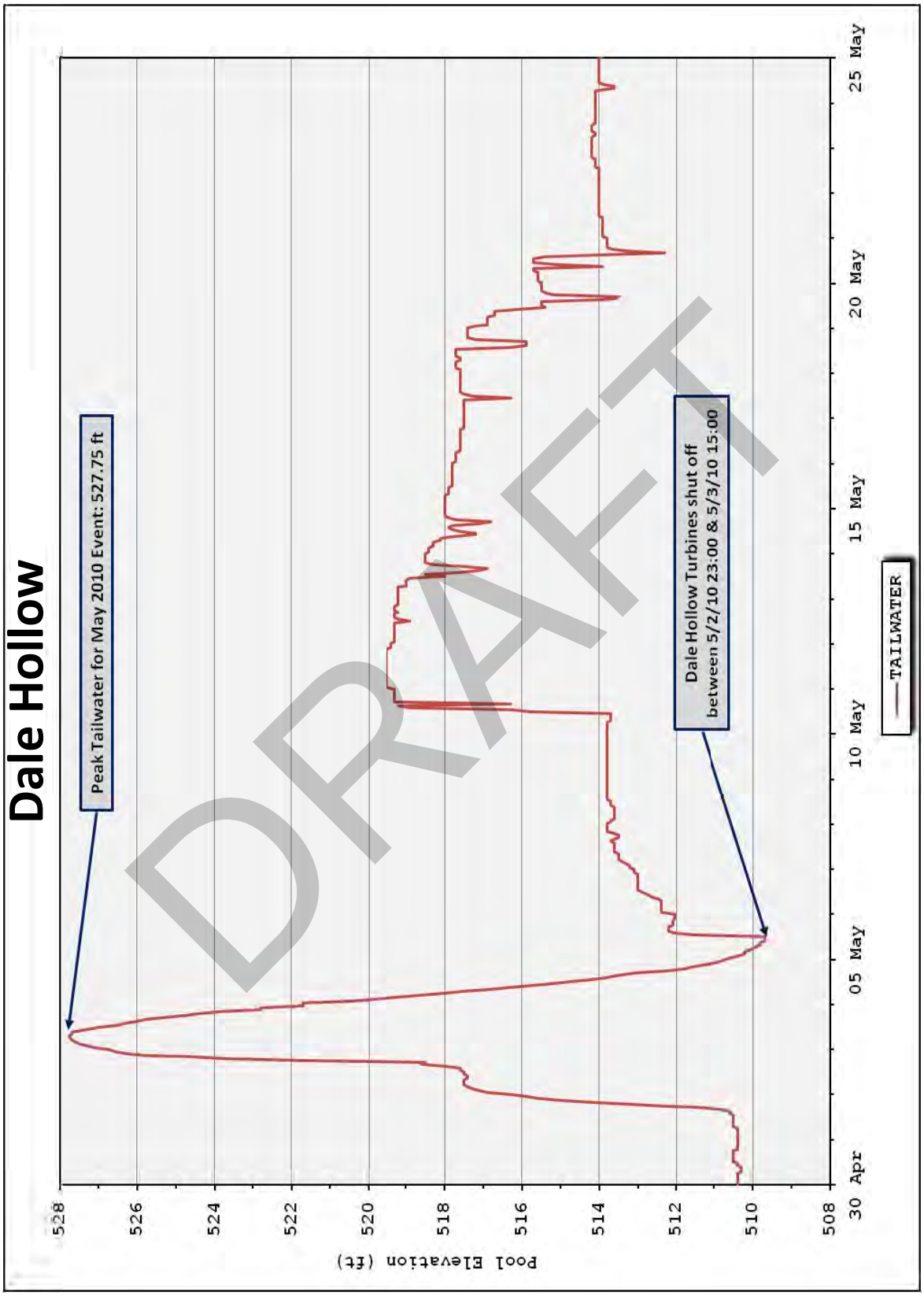
DRAFT


Old Hickory
Pool Elevation (ft)
452
450
448
446
444
442
440
438
436
434
432
430
428
426
424
422
420
418
416
414
412
410
408
406
404
402
400
398
396
394
392
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
Peak Tailwater for May 2010 Event: 435.20 ft
HEADWATER
TAILWATER
DRAFT

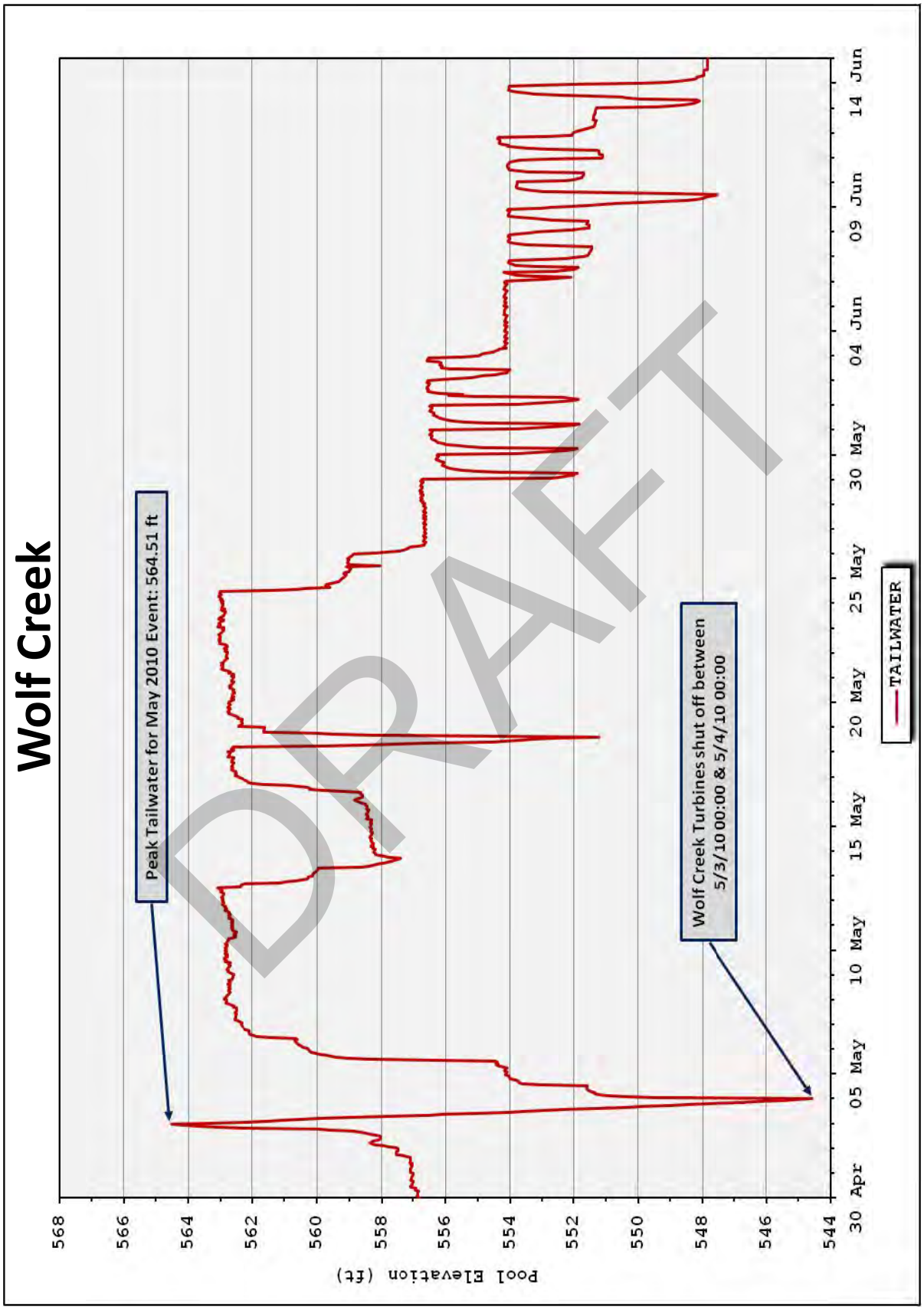

Center Hill
Peak Tailwater for May 2010 Event: 492.08 ft
Center Hill Turbines shut off between 5/2/10 21:00 & 5/4/10 00:00
Pool Elevation (ft)
493
492
491
490
489
488
487
486
485
484
483
482
481
480
479
478
477
476
475
30 Apr
05 May
10 May
15 May
20 May
25 May
TAILWATER

DRAFT


Cordell Hull
Pool Elevation (ft)
510
508
506
504
502
500
498
496
494
492
490
488
486
484
482
480
478
476
474
472
470
468
466
464
462
460
458
456
454
452
450
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
Peak Tailwater for May 2010 Event: 486.50 ft
Trash Dump
HEADWATER
TAILWATER
DRAFT


Dale Hollow
Peak Tailwater for May 2010 Event: 527.75 ft
Dale Hollow Turbines shut off
between 5/2/10 23:00 & 5/3/10 15:00
TAILWATER
Pool Elevation (ft)
528
526
524
522
520
518
516
514
512
510
508
30 Apr
05 May
10 May
15 May
20 May
25 May

DRAFT


Wolf Creek
Peak Tailwater for May 2010 Event: 564.51 ft
Wolf Creek Turbines shut off between 5/3/10 00:00 & 5/4/10 00:00
TAILWATER
Pool Elevation (ft)
568
566
564
562
560
558
556
554
552
550
548
546
544
30 Apr
05 May
10 May
15 May
20 May
25 May
30 May
04 Jun
09 Jun
14 Jun

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Damage Center Stages Plots

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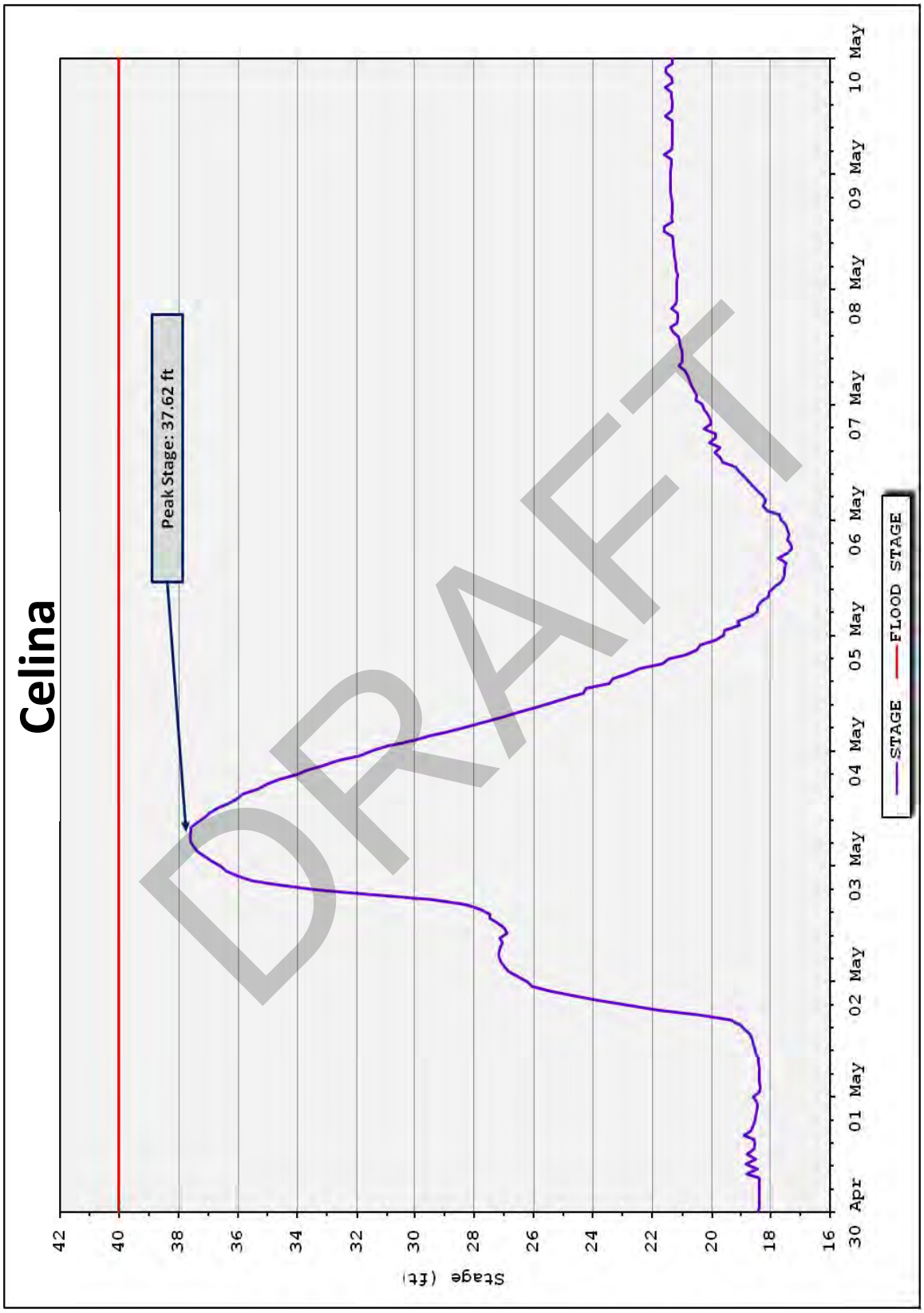
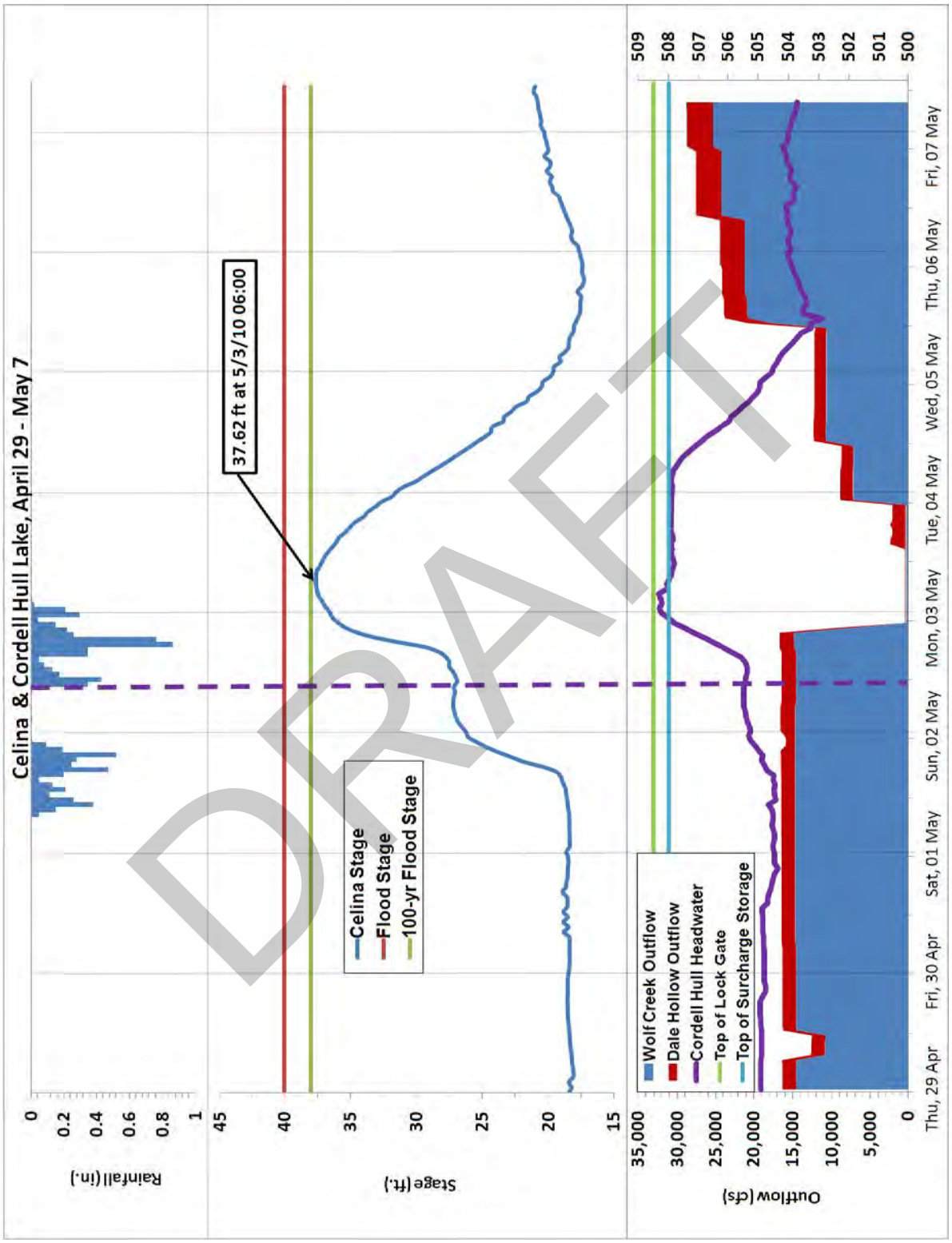
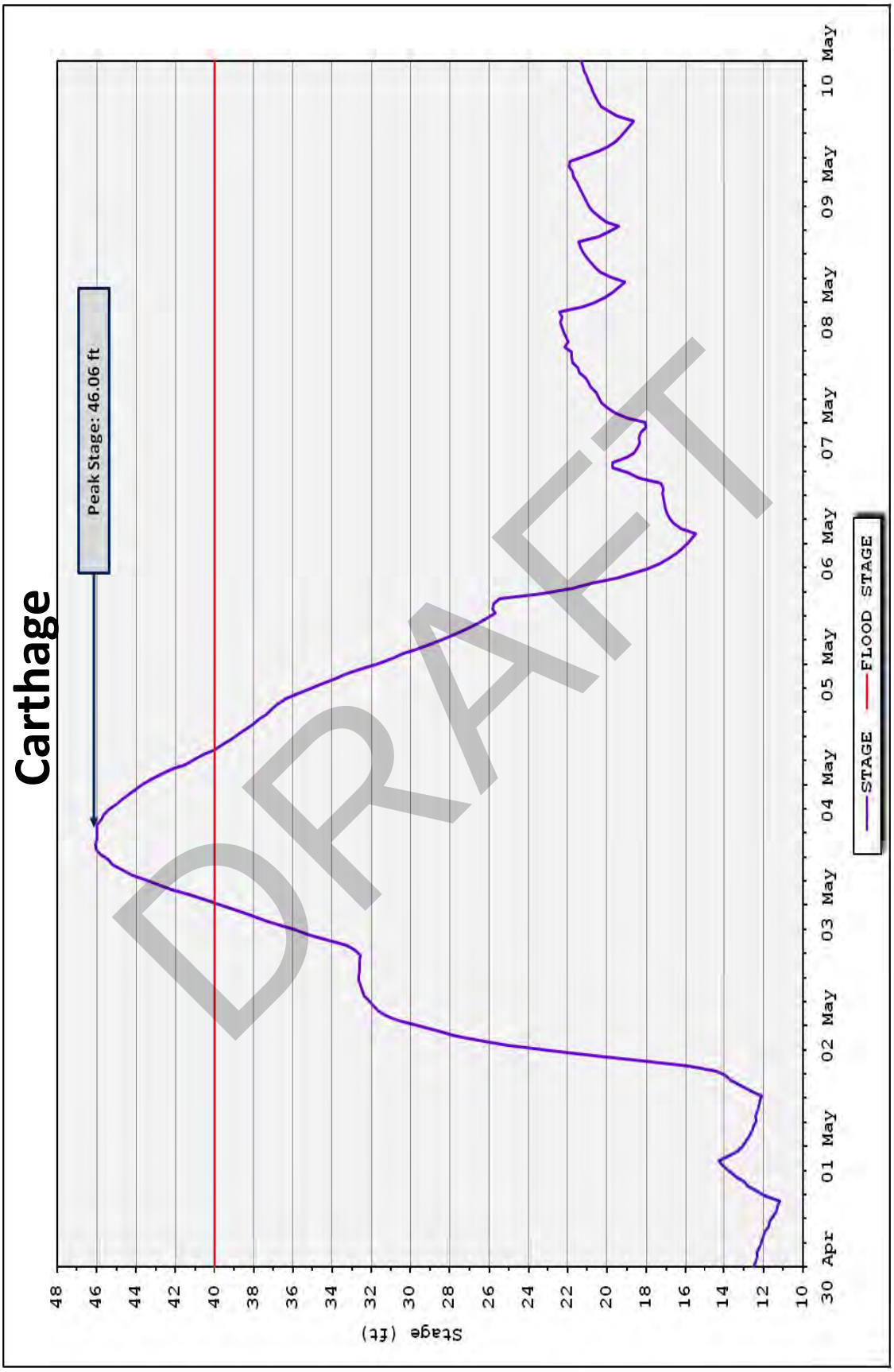
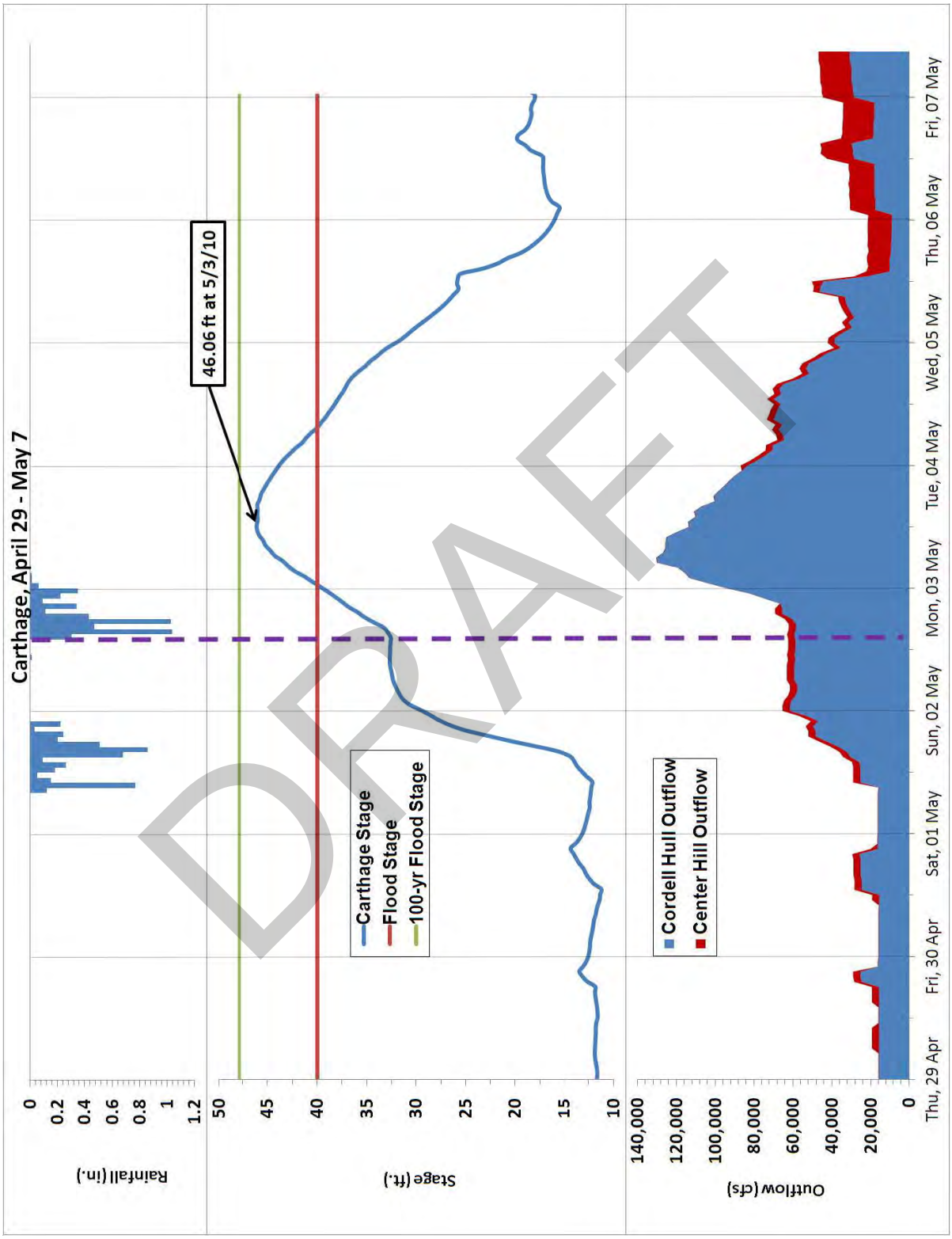

Celina
Peak Stage: 37.62 ft
Stage (ft)
42
40
38
36
34
32
30
28
26
24
22
20
18
16
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
STAGE
FLOOD STAGE

DRAFT

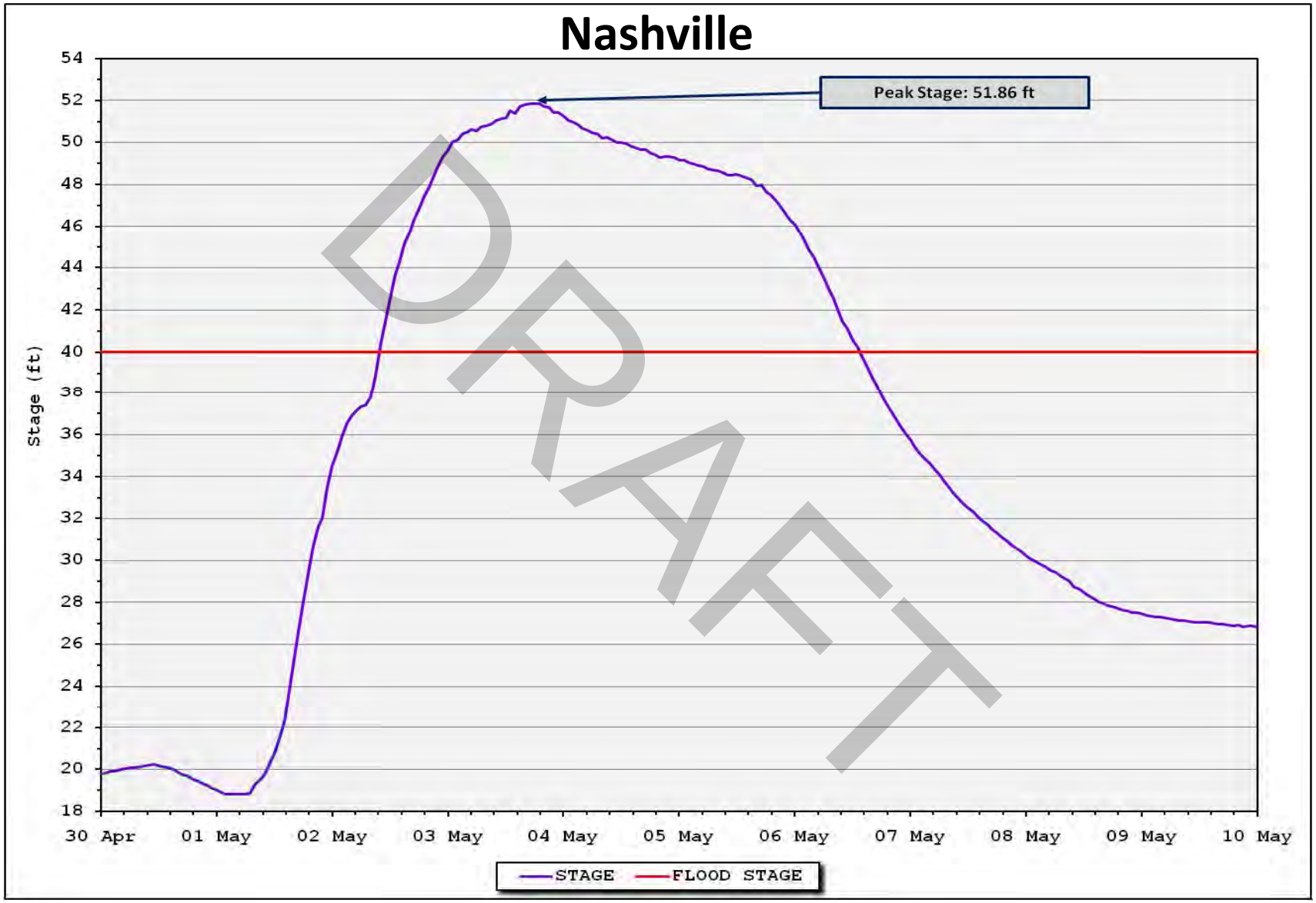

Celina & Cordell Hull Lake, April 29 - May 7
37.62 ft at 5/3/10 06:00
Celina Stage
Flood Stage
100-yr Flood Stage
Wolf Creek Outflow
Dale Hollow Outflow
Cordell Hull Headwater
Top of Lock Gate
Top of Surcharge Storage
Rainfall (in.)
Stage (ft.)
Outflow (cfs)
Thu, 29 Apr
Fri, 30 Apr
Sat, 01 May
Sun, 02 May
Mon, 03 May
Tue, 04 May
Wed, 05 May
Thu, 06 May
Fri, 07 May

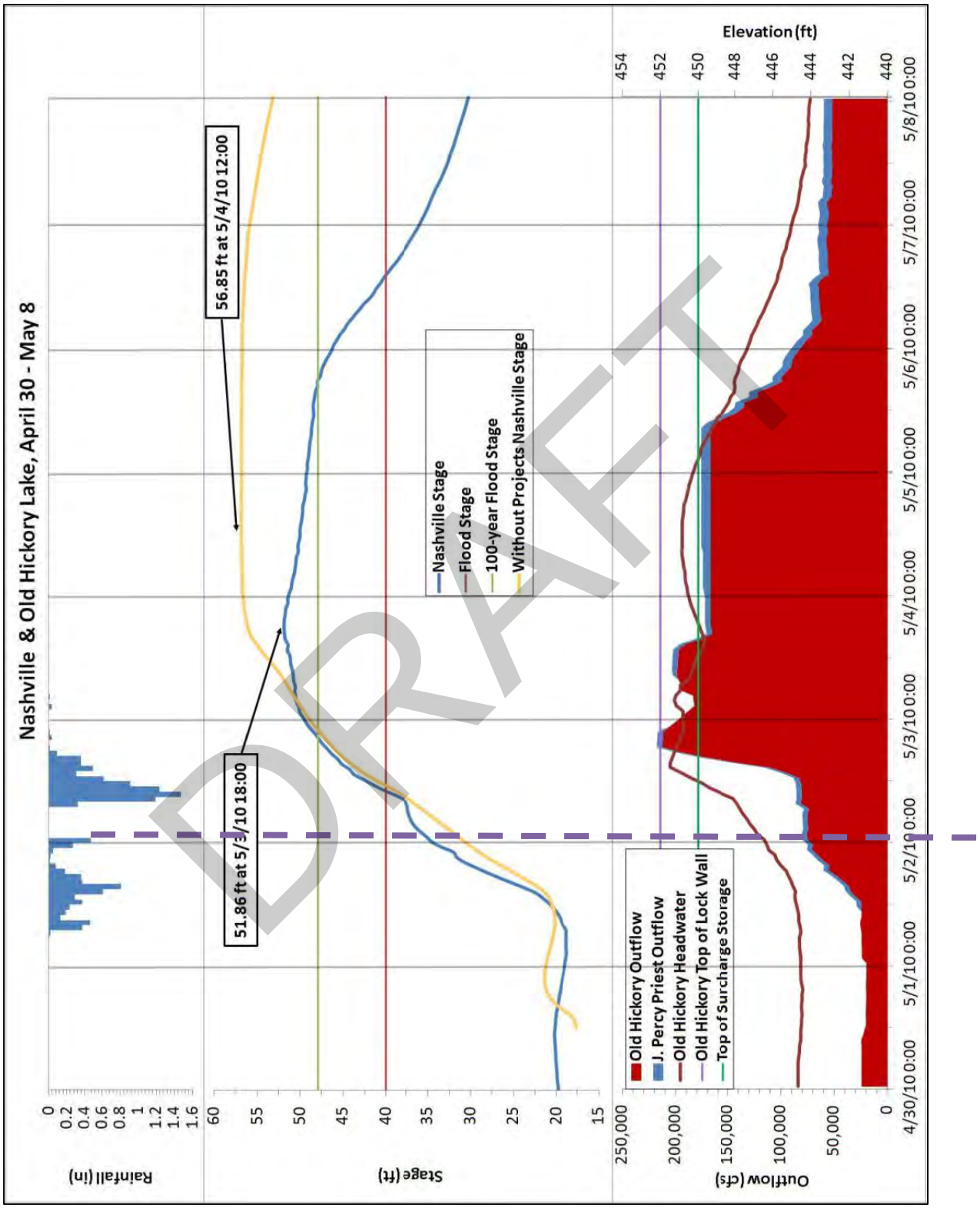
DRAFT


Carthage
Peak Stage: 46.06 ft
Stage (ft)
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
STAGE
FLOOD STAGE
DRAFT

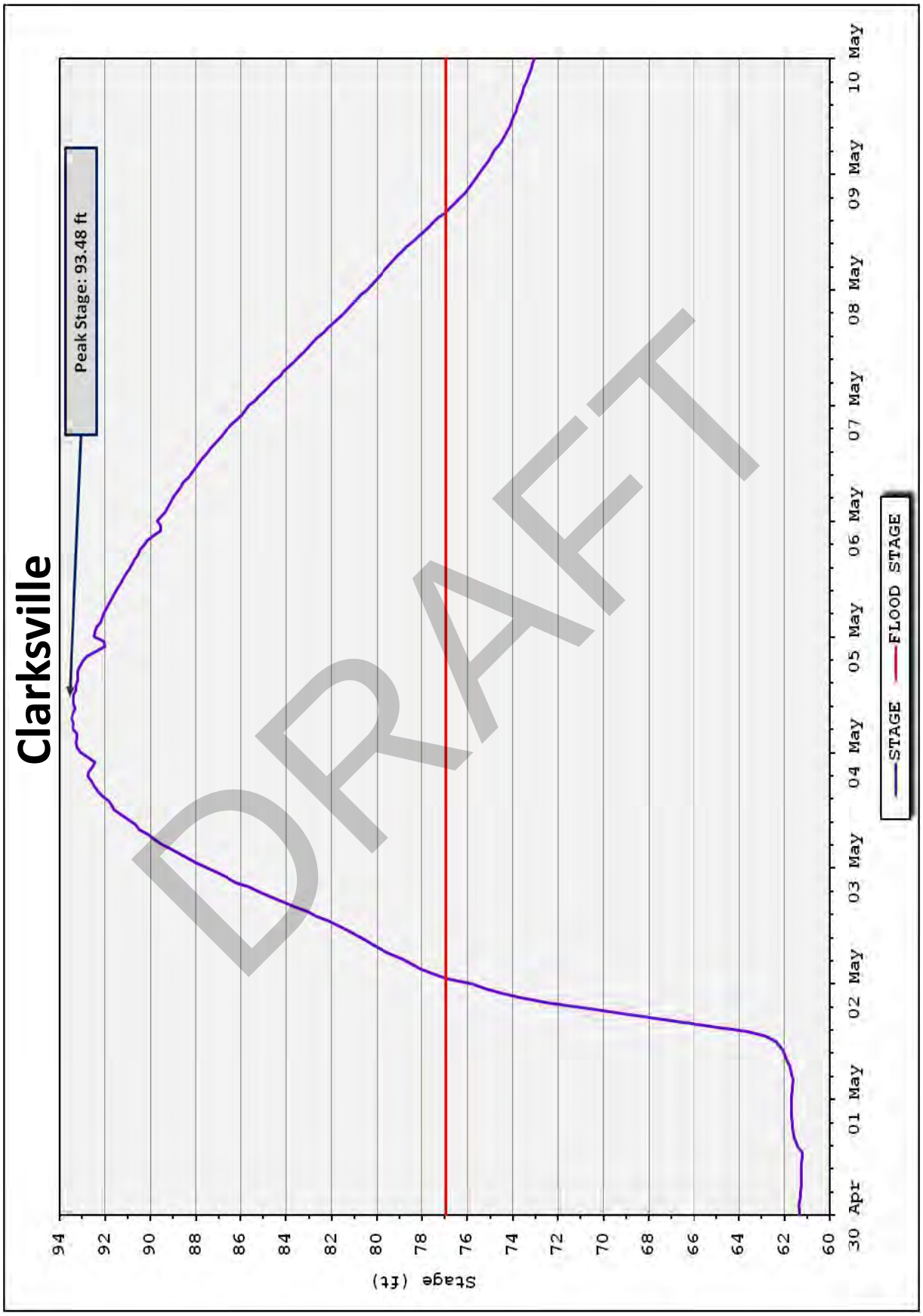

Carthage, April 29 - May 7
46.06 ft at 5/3/10
Rainfall (in.)
0
0.2
0.4
0.6
0.8
1
1.2
Stage (ft.)
50
45
40
35
30
25
20
15
10
Carthage Stage
Flood Stage
100-yr Flood Stage
Outflow (cfs)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Cordell Hull Outflow
Center Hill Outflow
Thu, 29 Apr
Fri, 30 Apr
Sat, 01 May
Sun, 02 May
Mon, 03 May
Tue, 04 May
Wed, 05 May
Thu, 06 May
Fri, 07 May

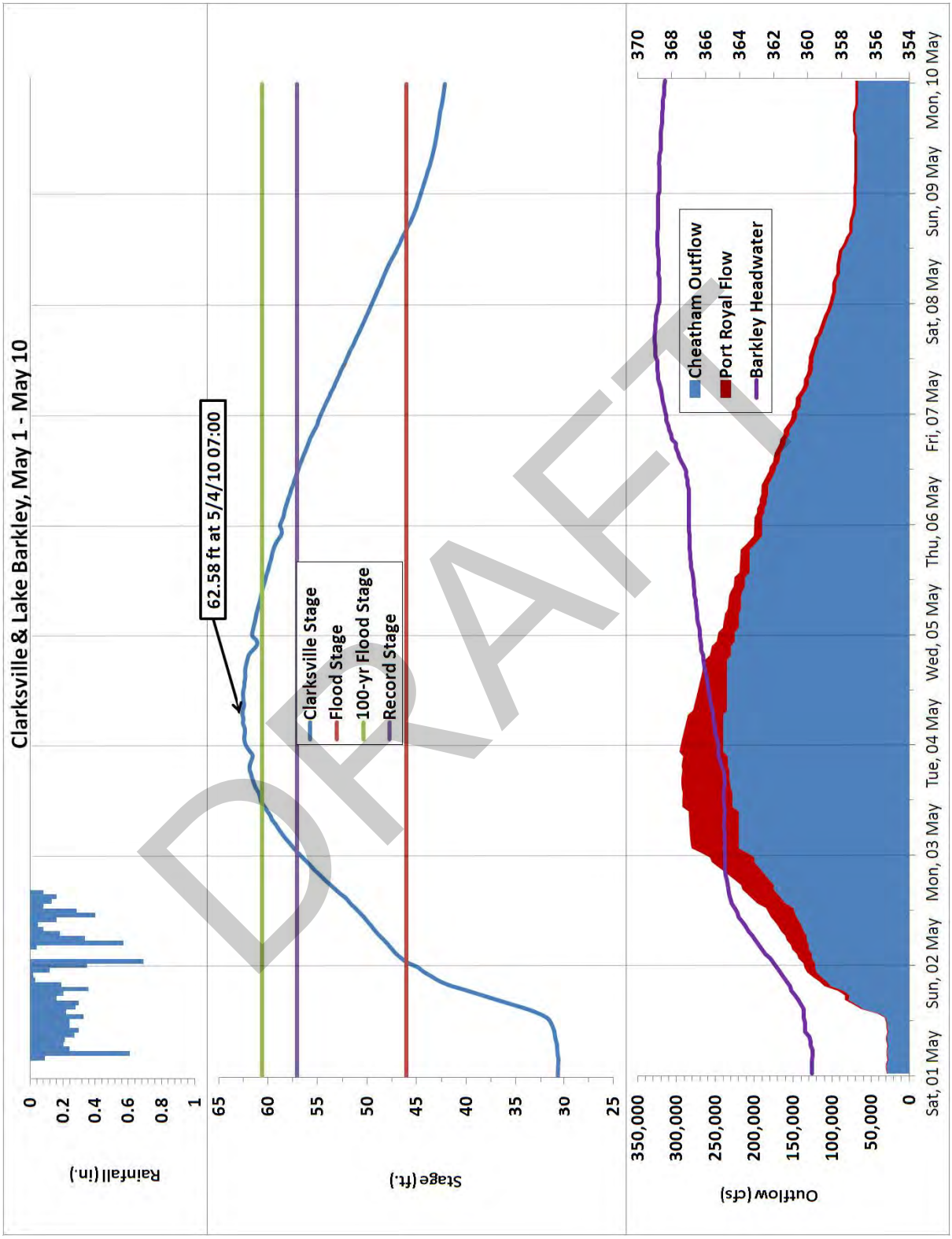
DRAFT


Nashville
Peak Stage: 51.86 ft
Stage (ft)
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
STAGE
FLOOD STAGE
DRAFT


Nashville & Old Hickory Lake, April 30 - May 8
Rainfall (in)
Stage (ft)
Outflow (cfs)
Elevation (ft)
56.85 ft at 5/4/10 12:00
51.86 ft at 5/3/10 18:00
Nashville Stage
Flood Stage
100-year Flood Stage
Without Projects Nashville Stage
Old Hickory Outflow
J. Percy Priest Outflow
Old Hickory Headwater
Old Hickory Top of Lock Wall
Top of Surcharge Storage
4/30/10 0:00
5/1/10 0:00
5/2/10 0:00
5/3/10 0:00
5/4/10 0:00
5/5/10 0:00
5/6/10 0:00
5/7/10 0:00
5/8/10 0:00

DRAFT


Clarksville
Peak Stage: 93.48 ft
Stage (ft)
94
92
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
STAGE
FLOOD STAGE
DRAFT


Clarksville & Lake Barkley, May 1 - May 10
Rainfall (in.)
0
0.2
0.4
0.6
0.8
1
Stage (ft.)
65
60
55
50
45
40
35
30
25
62.58 ft at 5/4/10 07:00
Clarksville Stage
Flood Stage
100-yr Flood Stage
Record Stage
Outflow (cfs)
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
370
368
366
364
362
360
358
356
354
Cheatham Outflow
Port Royal Flow
Barkley Headwater
Sat, 01 May
Sun, 02 May
Mon, 03 May
Tue, 04 May
Wed, 05 May
Thu, 06 May
Fri, 07 May
Sat, 08 May
Sun, 09 May
Mon, 10 May

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Plots of Stream Gage Discharges

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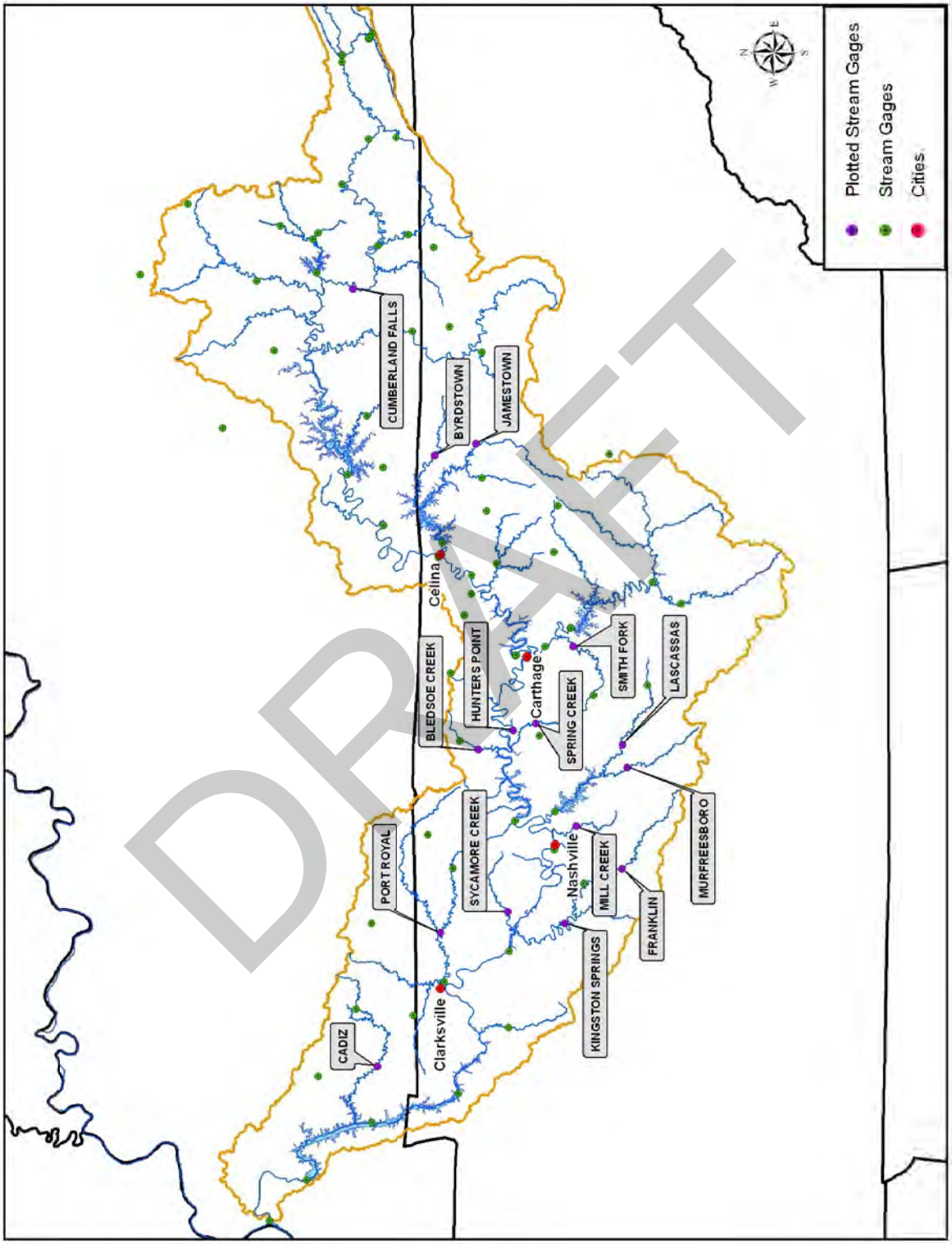
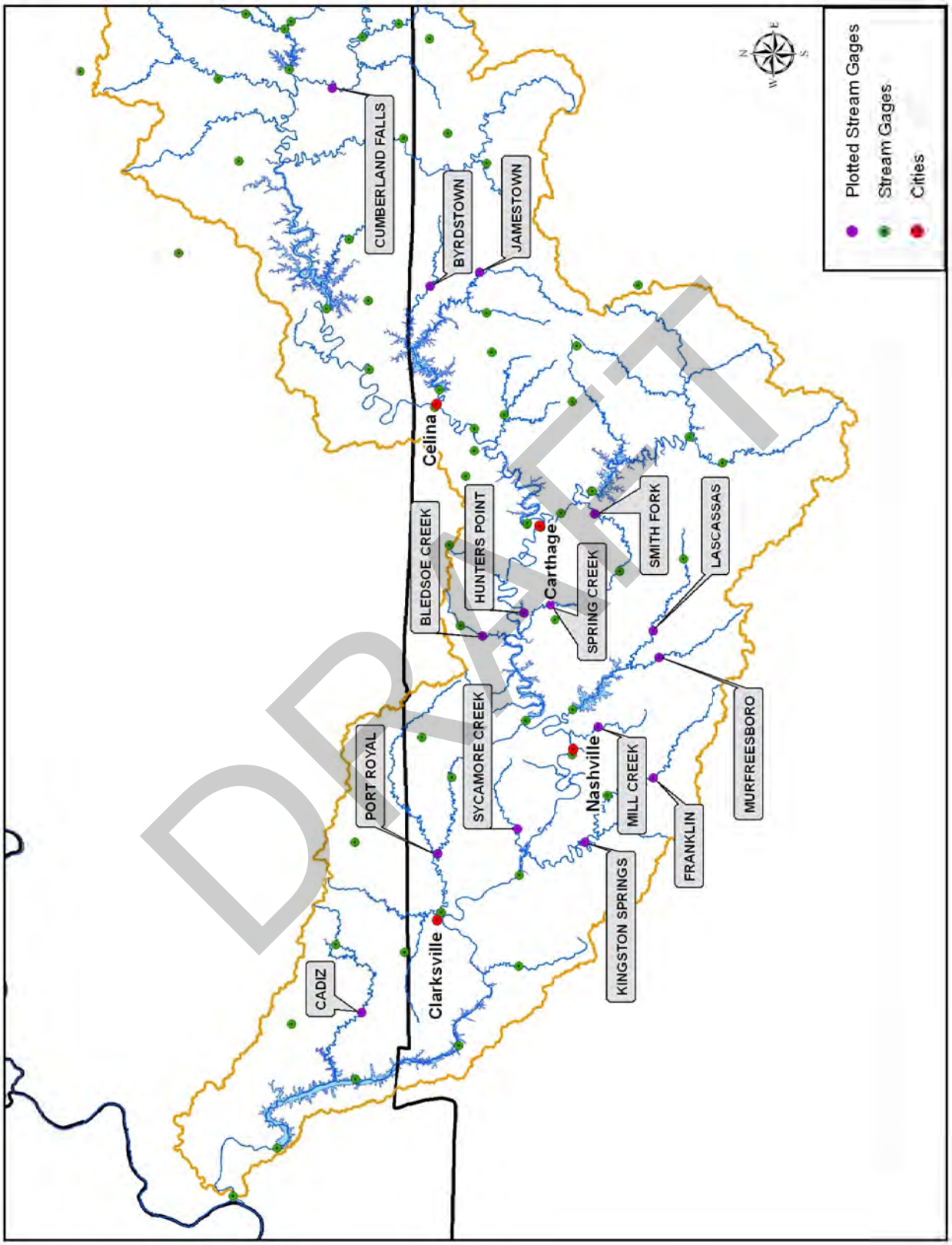
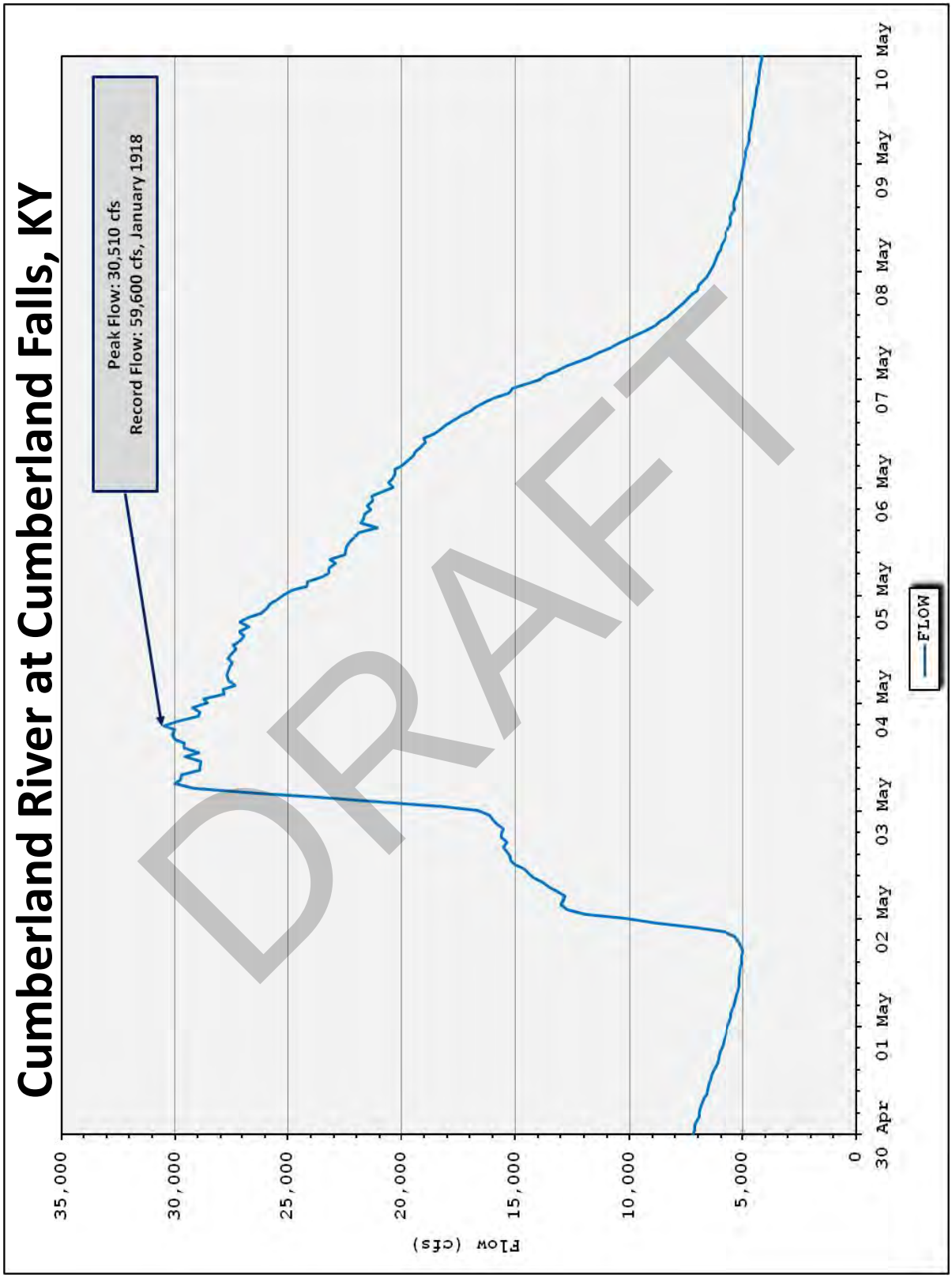

Plotted Stream Gages
Stream Gages
Cities
CUMBERLAND FALLS
BYRDSTOWN
JAMESTOWN
Celina
BLEDSOE CREEK
HUNTERS POINT
Carthage
SPRING CREEK
SMITH FORK
LASCASSAS
MURFREESBORO
PORT ROYAL
SYCAMORE CREEK
Nashville
MILL CREEK
FRANKLIN
KINGSTON SPRINGS
Clarksville
CADIZ
N
E
S
W

DRAFT


CUMBERLAND FALLS
BYRDSTOWN
JAMESTOWN
Celina
BLEDSOE CREEK
HUNTERS POINT
Carthage
SPRING CREEK
SMITH FORK
LASCASSAS
PORT ROYAL
SYCAMORE CREEK
Nashville
MILL CREEK
MURFREESBORO
FRANKLIN
KINGSTON SPRINGS
Clarksville
CADIZ
Plotted Stream Gages
Stream Gages
Cities
N
E
S
W

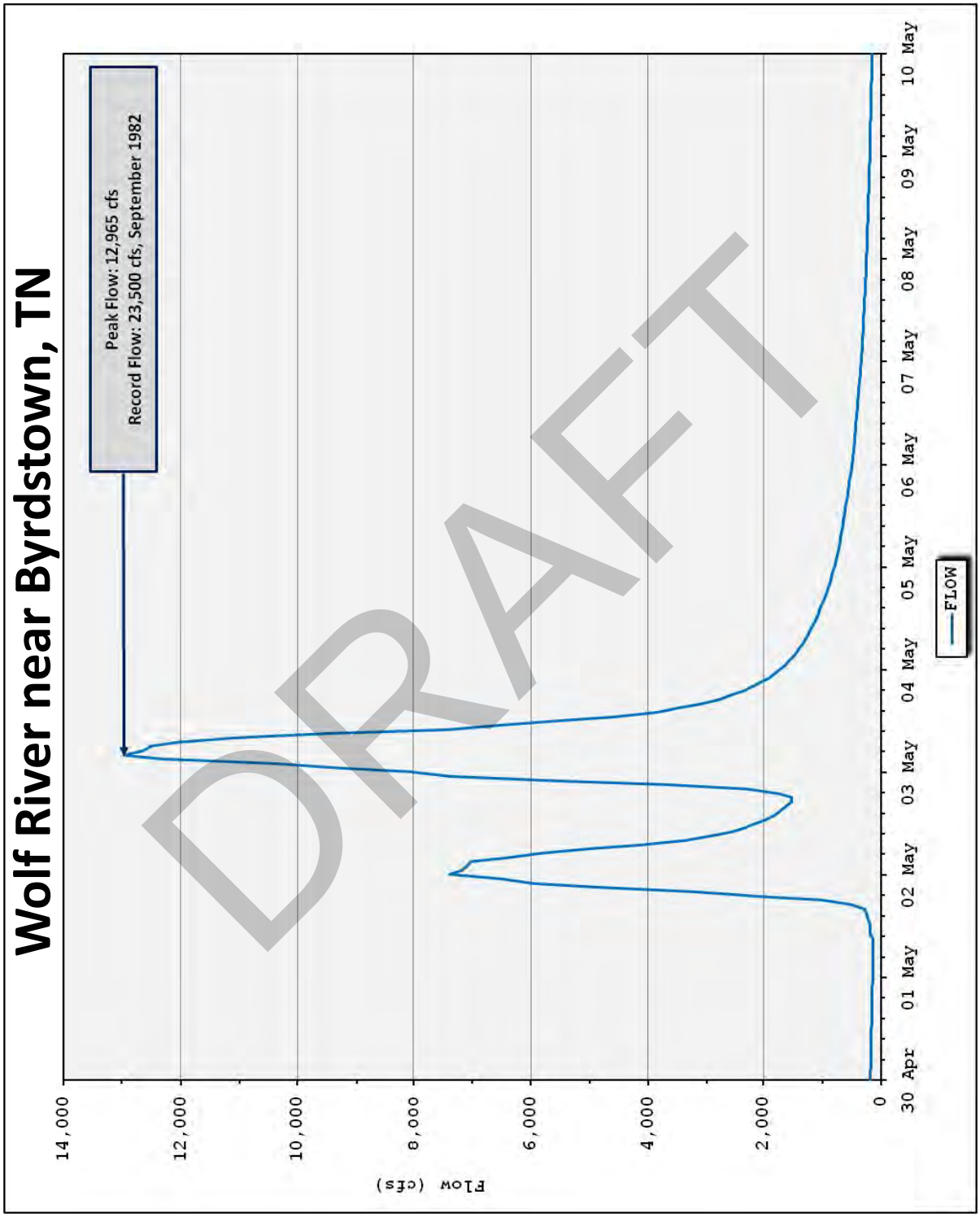
DRAFT


Cumberland River at Cumberland Falls, KY
Peak Flow: 30,510 cfs
Record Flow: 59,600 cfs, January 1918
Flow (cfs)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW

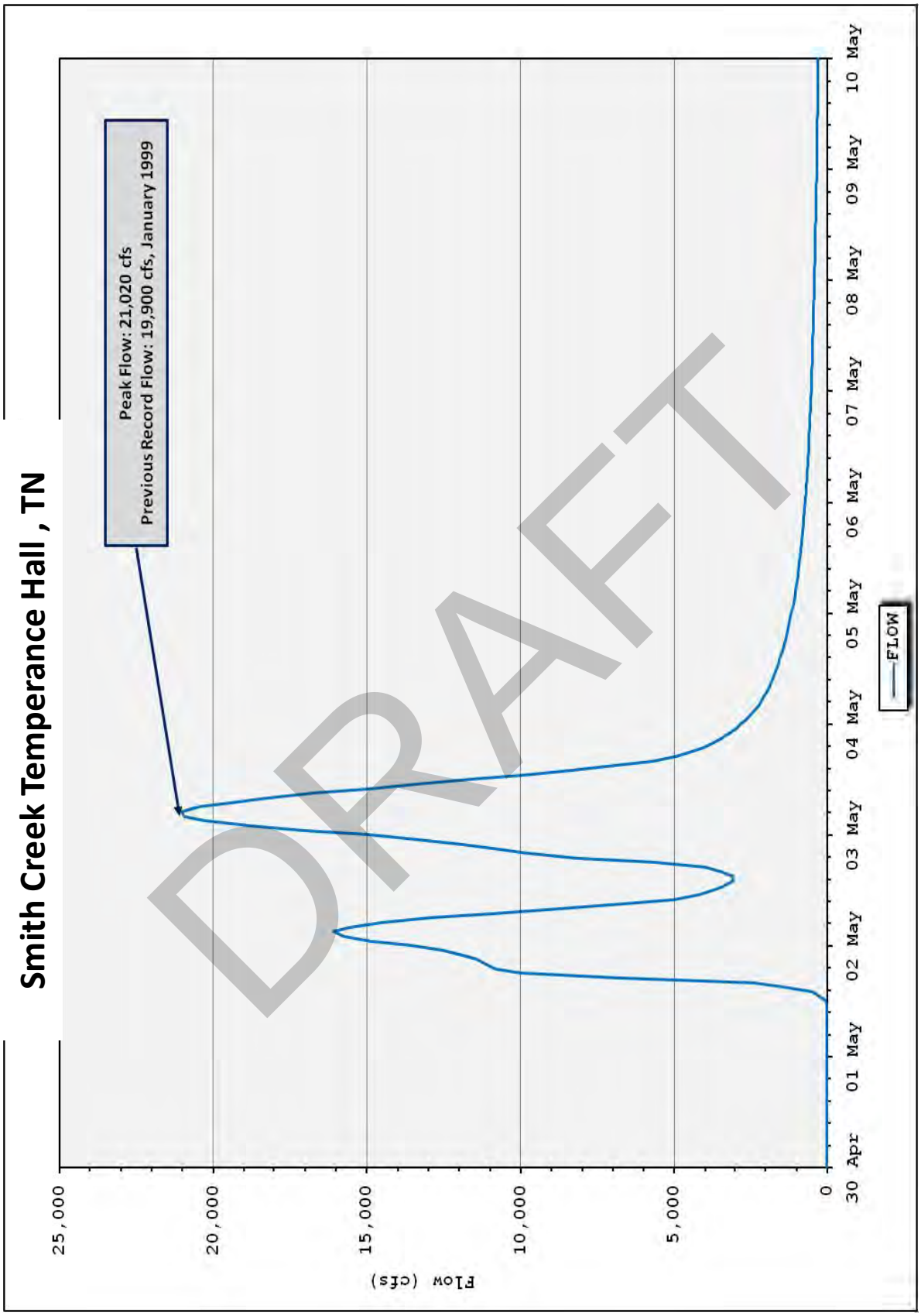
DRAFT

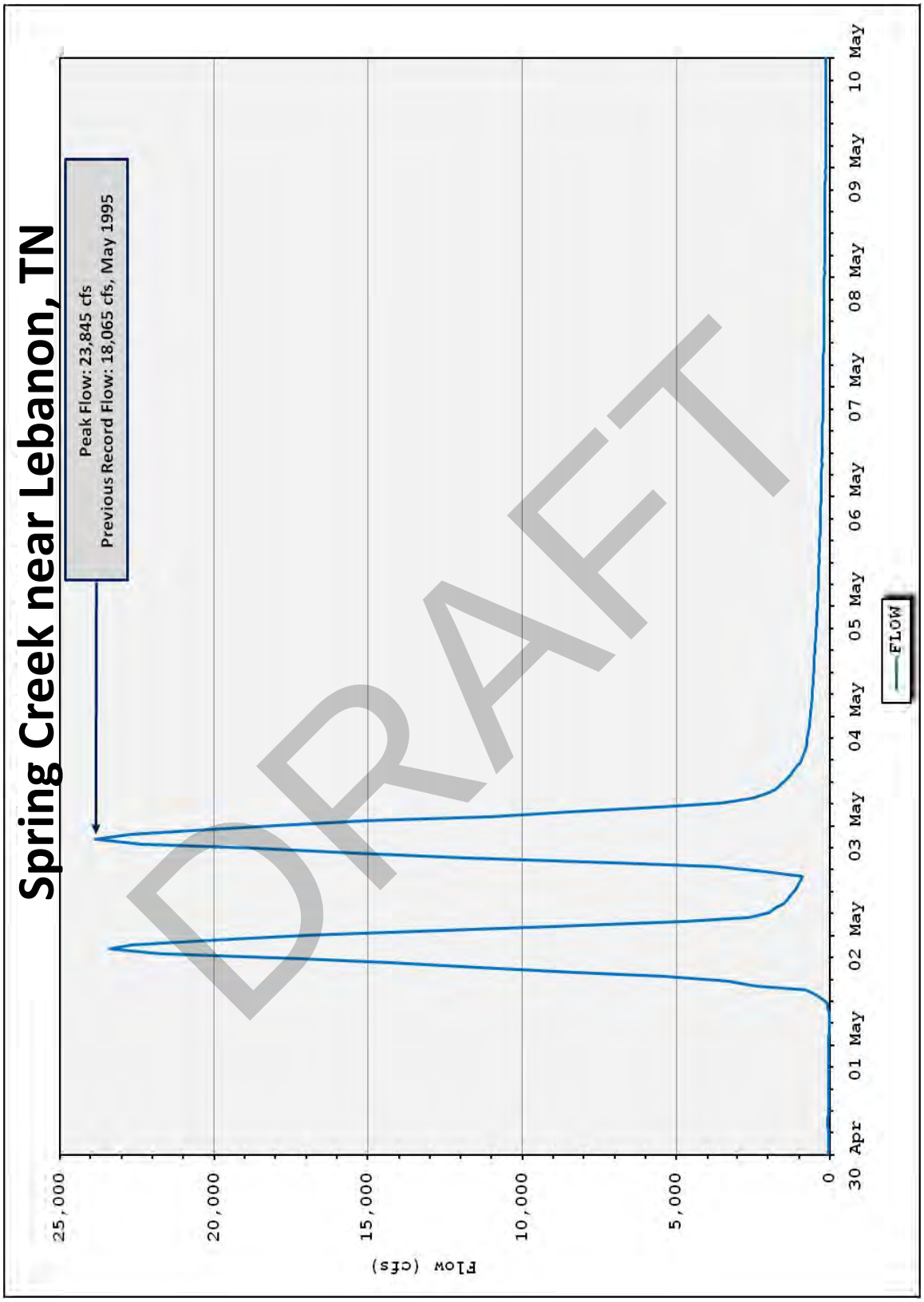
East Fork Obey River near Jamestown, TN
Peak Flow: 13,450 cfs
Record Flow: 44,800 cfs, May 1973
Flow (cfs)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW

DRAFT

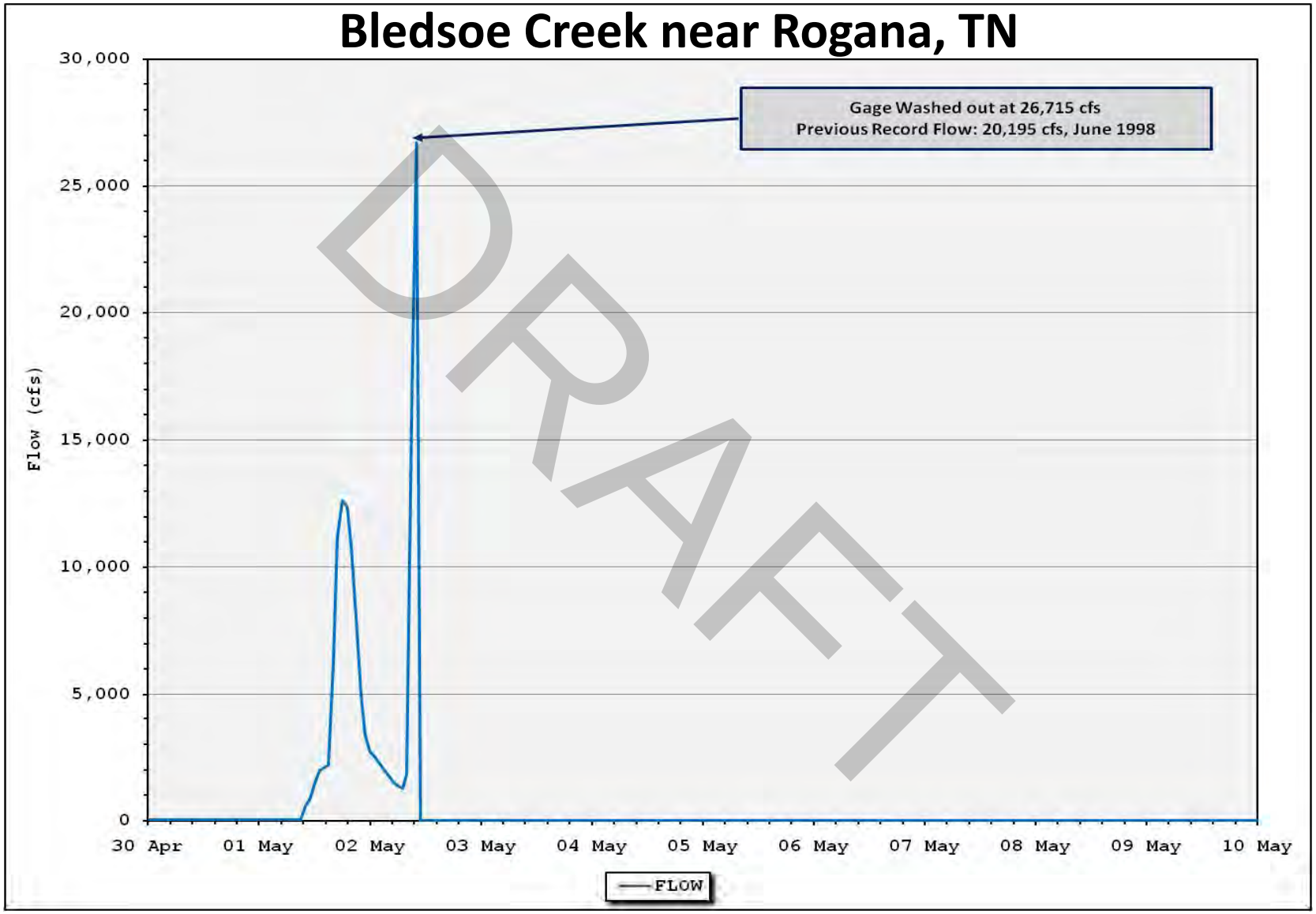

Wolf River near Byrdstown, TN
Peak Flow: 12,965 cfs
Record Flow: 23,500 cfs, September 1982
Flow (cfs)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW

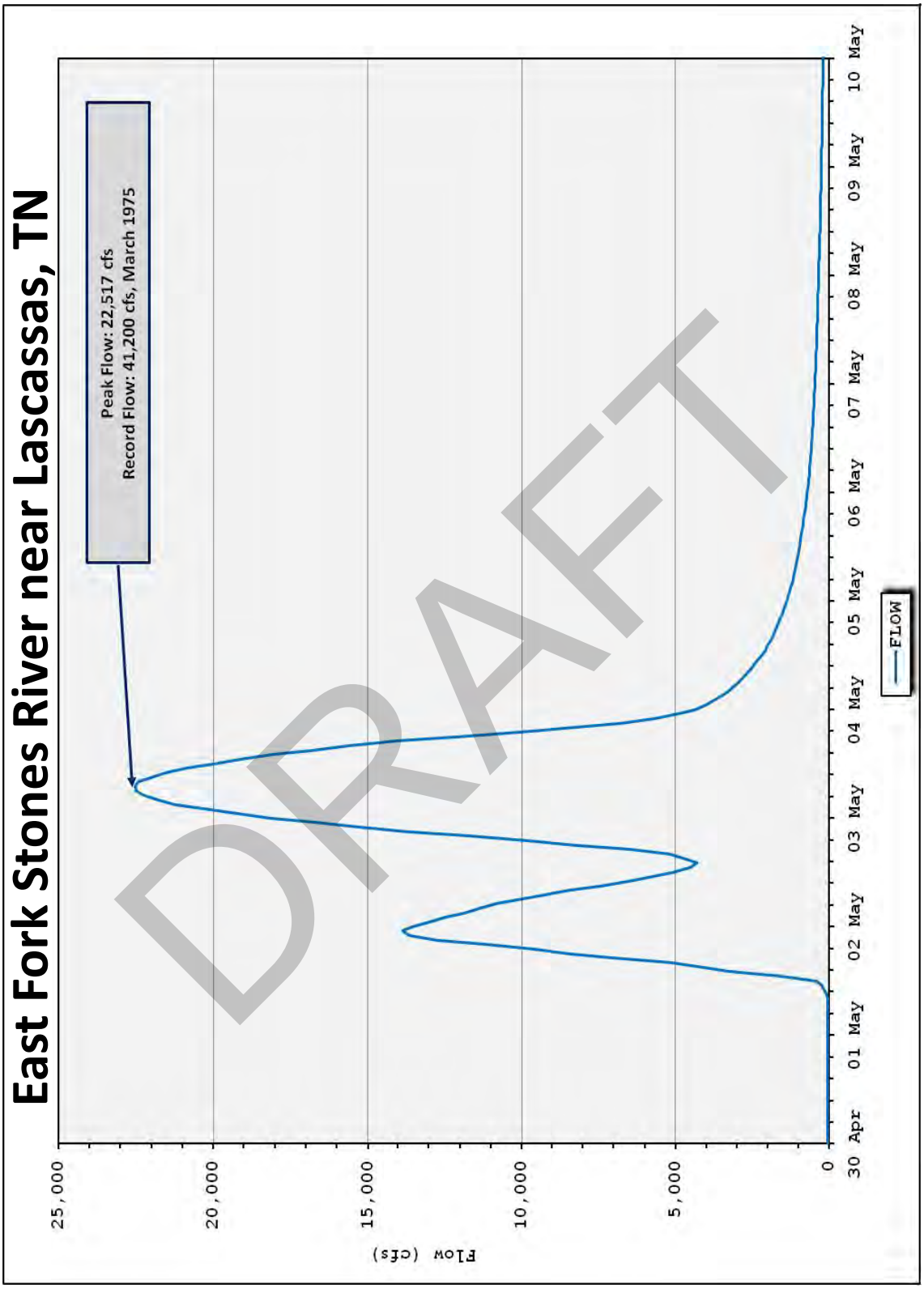
DRAFT

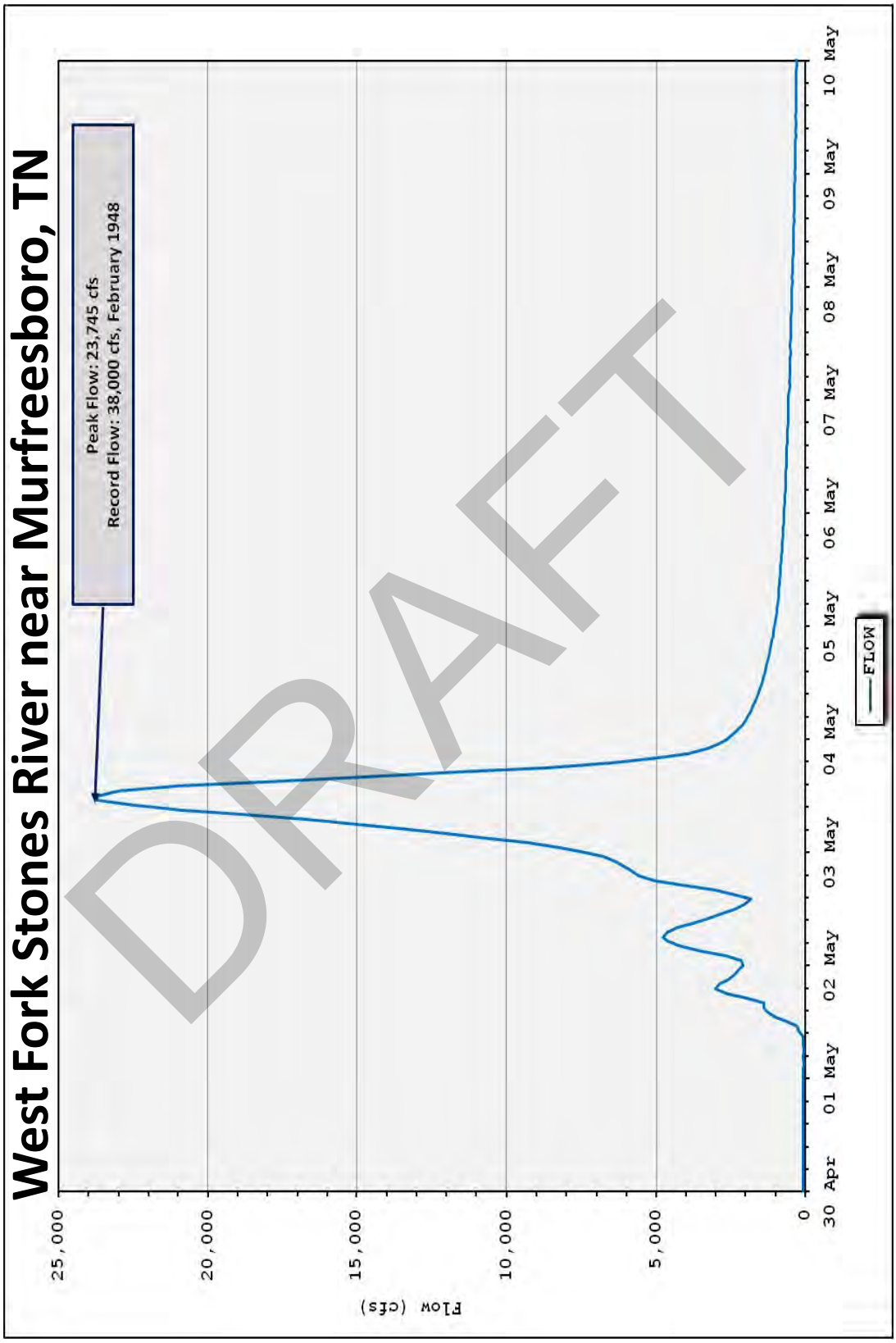

Smith Creek Temperance Hall , TN
Peak Flow: 21,020 cfs
Previous Record Flow: 19,900 cfs, January 1999
Flow (cfs)
25,000
20,000
15,000
10,000
5,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW
DRAFT

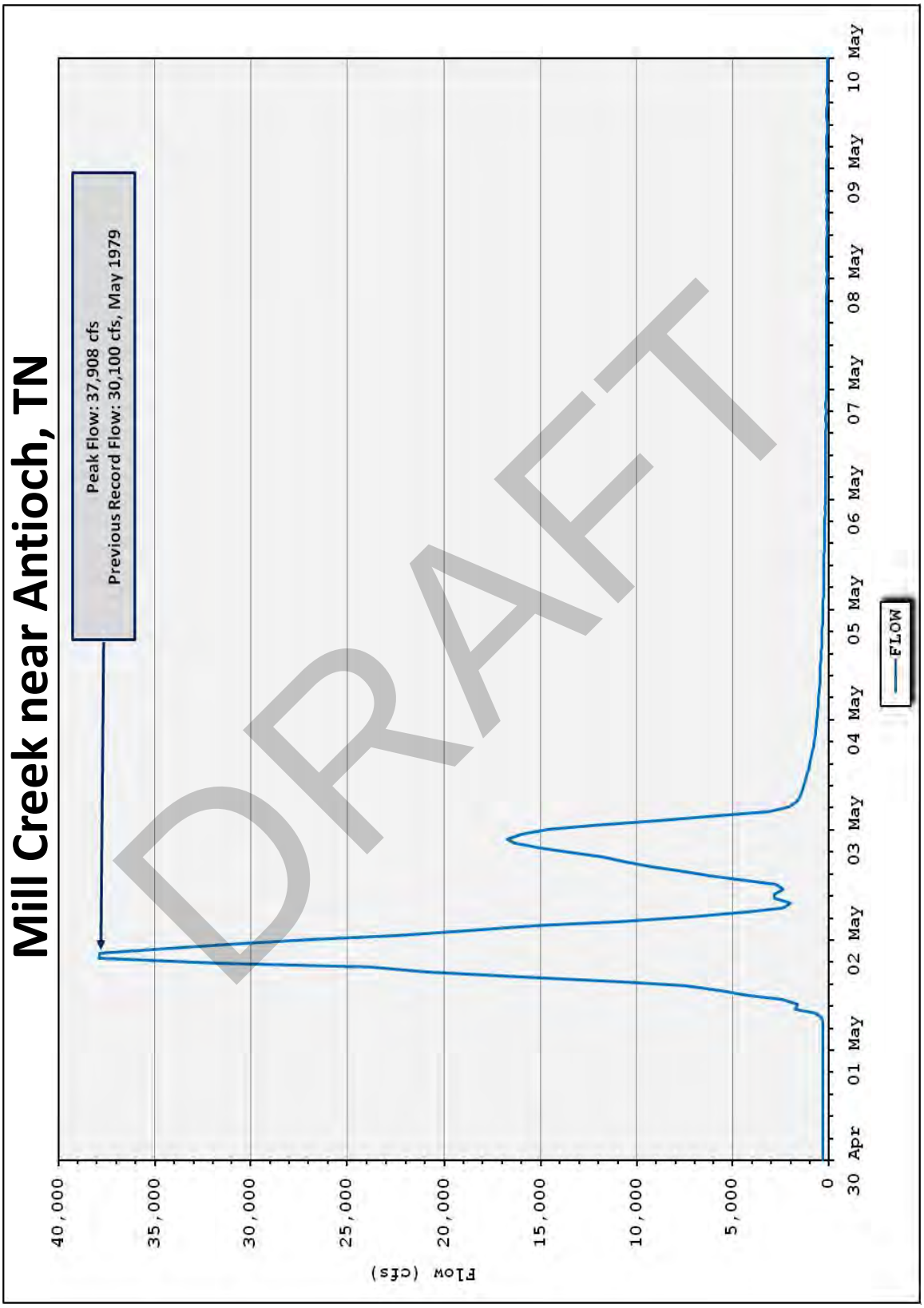

Spring Creek near Lebanon, TN
Peak Flow: 23,845 cfs
Previous Record Flow: 18,065 cfs, May 1995
Flow (cfs)
25,000
20,000
15,000
10,000
5,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW

DRAFT

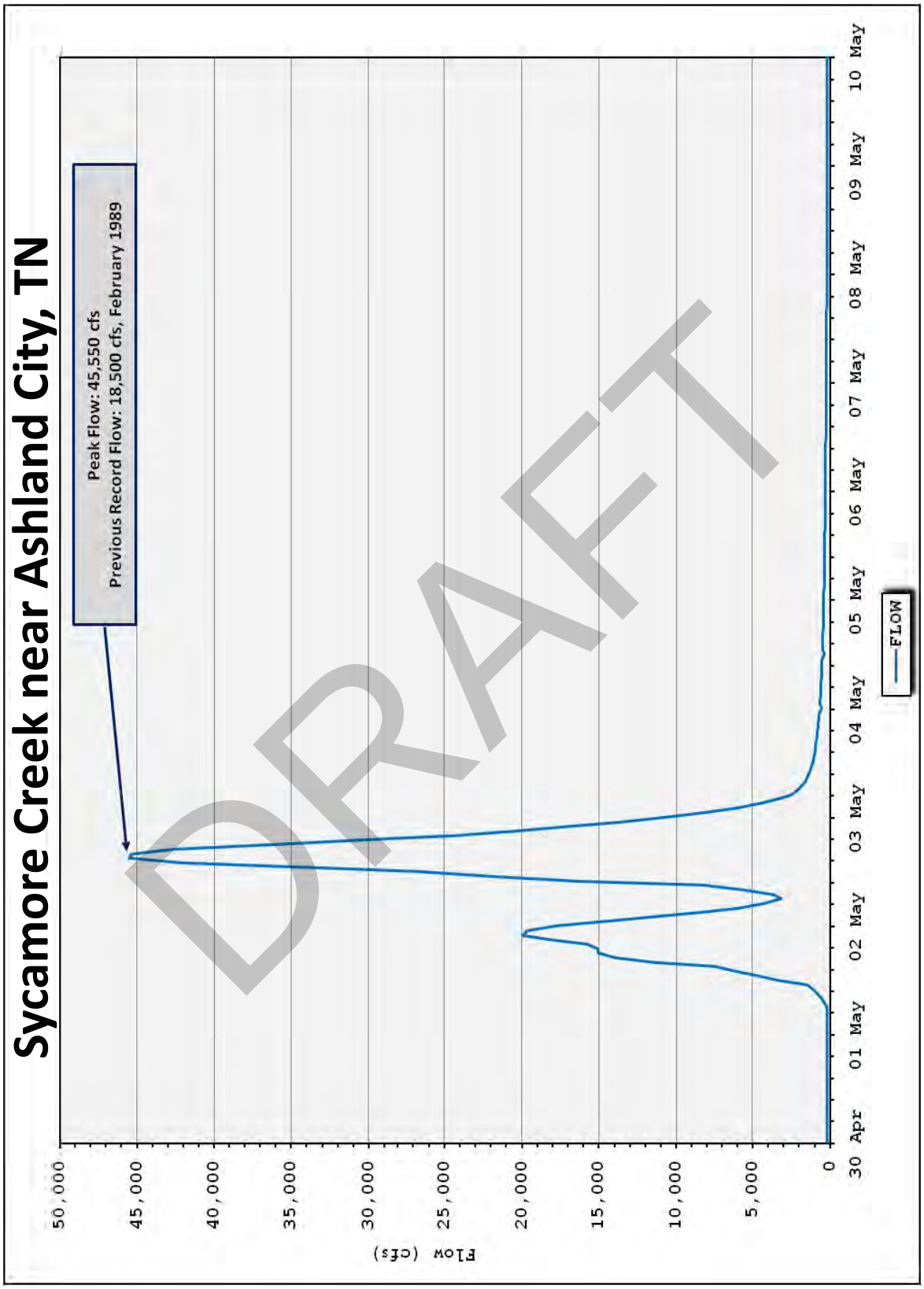

Bledsoe Creek near Rogana, TN
Gage Washed out at 26,715 cfs
Previous Record Flow: 20,195 cfs, June 1998
Flow (cfs)
30,000
25,000
20,000
15,000
10,000
5,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW
DRAFT

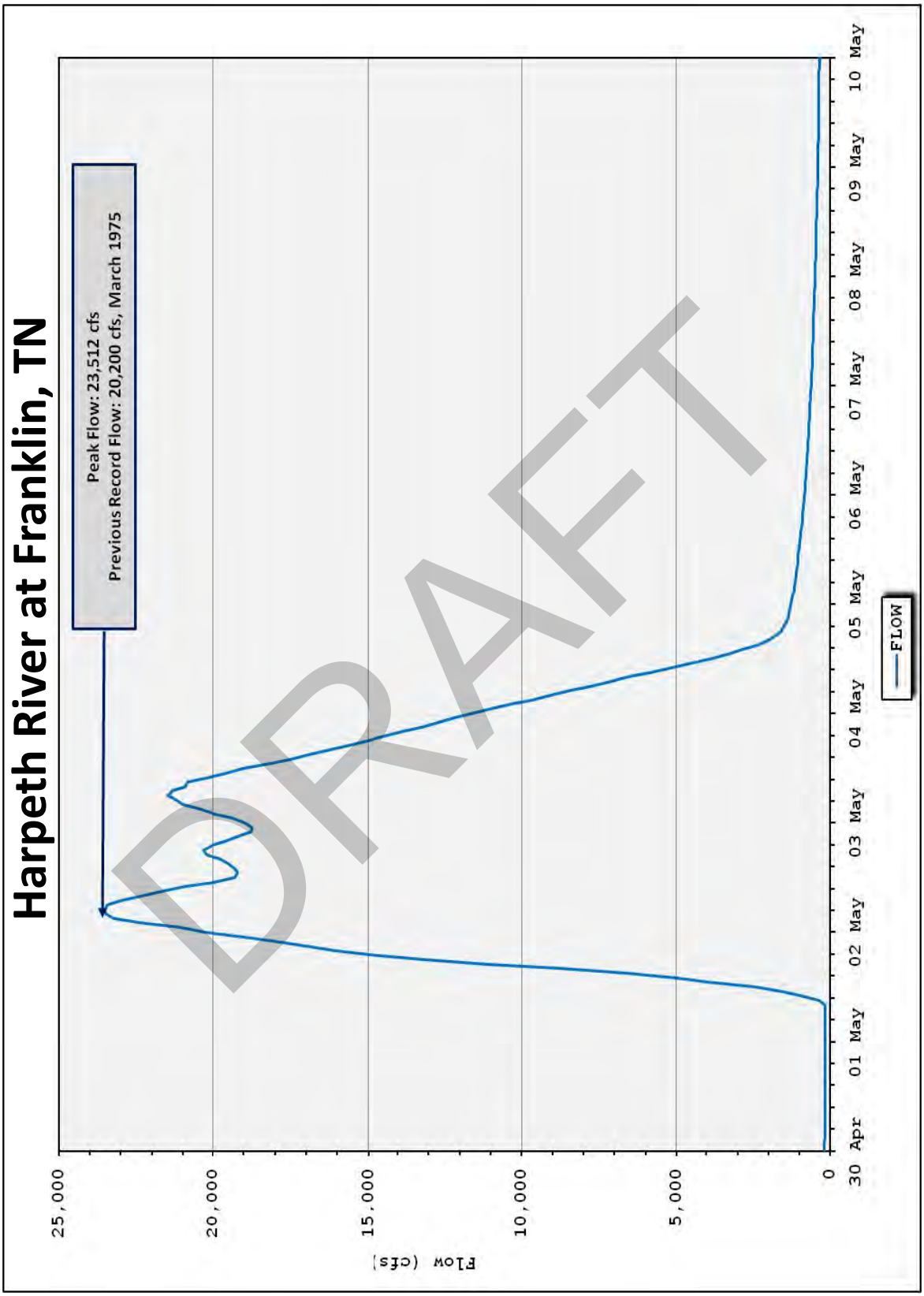

East Fork Stones River near Lascassas, TN
Peak Flow: 22,517 cfs
Record Flow: 41,200 cfs, March 1975
Flow (cfs)
25,000
20,000
15,000
10,000
5,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW
DRAFT


West Fork Stones River near Murfreesboro, TN
Peak Flow: 23,745 cfs
Record Flow: 38,000 cfs, February 1948
Flow (cfs)
25,000
20,000
15,000
10,000
5,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW
DRAFT


Mill Creek near Antioch, TN
Peak Flow: 37,908 cfs
Previous Record Flow: 30,100 cfs, May 1979
Flow (cfs)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW

DRAFT


Sycamore Creek near Ashland City, TN
Peak Flow: 45,550 cfs
Previous Record Flow: 18,500 cfs, February 1989
Flow (cfs)
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW
DRAFT


Harpeth River at Franklin, TN
Peak Flow: 23,512 cfs
Previous Record Flow: 20,200 cfs, March 1975
Flow (cfs)
25,000
20,000
15,000
10,000
5,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW
DRAFT

Harpeth River at Kingston Springs, TN

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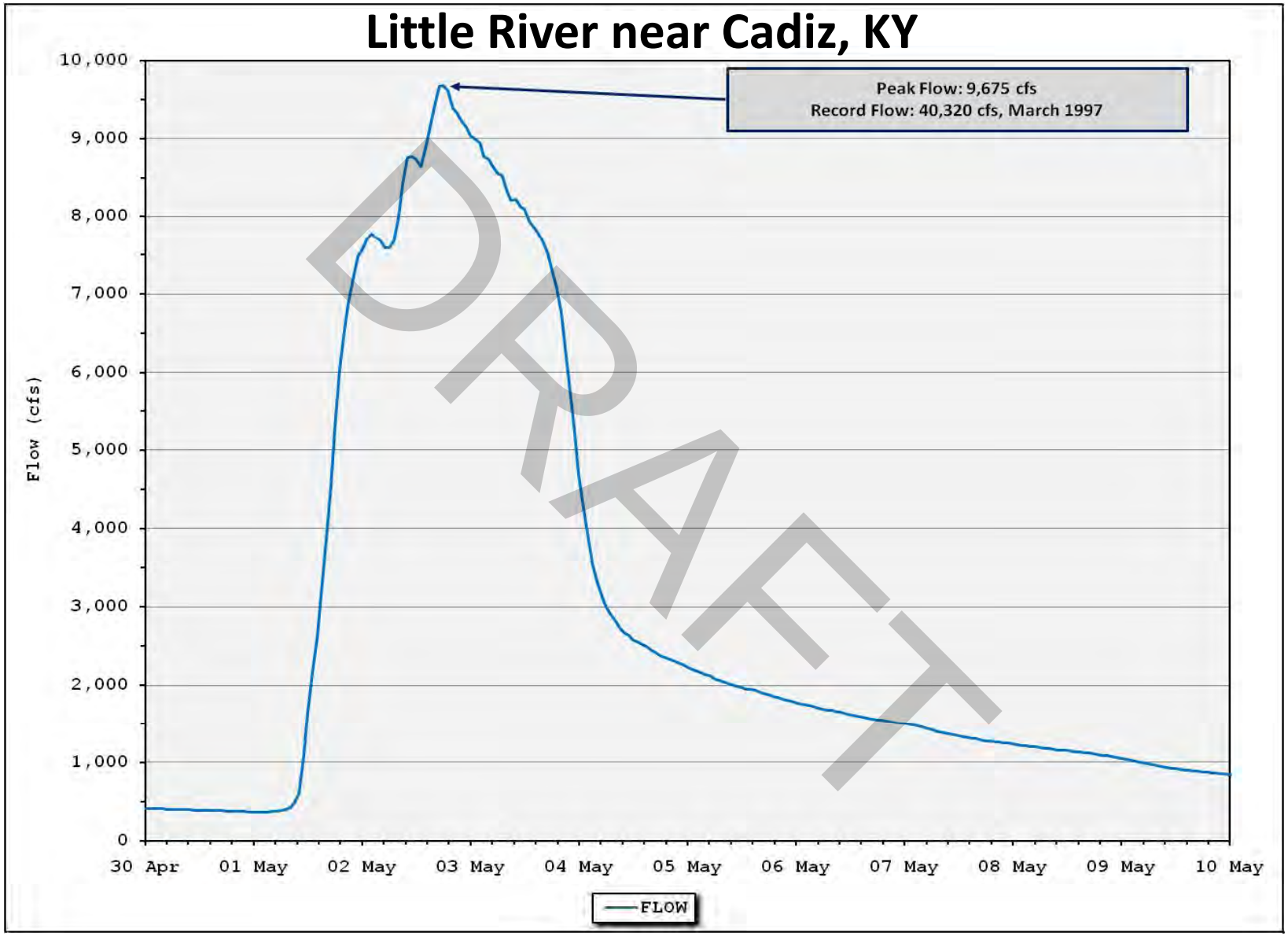
Red River at Port Royal, TN
Peak Flow: 64,673 cfs
Previous Record Flow: 60,300 cfs, March 1975
Flow (cfs)
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW
DRAFT


Little River near Cadiz, KY
Peak Flow: 9,675 cfs
Record Flow: 40,320 cfs, March 1997
Flow (cfs)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
FLOW
DRAFT

Cumberland River at Hunters Point – River Mile 263 (Old Hickory Project)
Peak Elevation: 458.75 ft
Previous Record Elevation: 453.64 ft, February 2004
Water Surface Elevation (ft)
460
459
458
457
456
455
454
453
452
451
450
449
448
447
446
445
444
30 Apr
01 May
02 May
03 May
04 May
05 May
06 May
07 May
08 May
09 May
10 May
WATER SURFACE ELEVATION
DRAFT

Project Tables

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010													
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Total Discharge cfs	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Total Discharge cfs	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Total Discharge cfs	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Total Discharge cfs
29-Apr-2010	1:00	504.90	450.90	15,800	445.07	393.27	19,200	384.98	362.98	14,800	360.10	312.90	42,200
29-Apr-2010	2:00	504.90	450.90	15,800	445.07	393.37	19,200	385.09	362.59	14,600	360.10	313.00	42,200
29-Apr-2010	3:00	504.90	450.90	15,800	445.07	393.37	19,200	385.20	362.10	14,400	360.10	313.10	41,900
29-Apr-2010	4:00	504.90	450.90	15,800	445.07	393.27	19,200	385.30	362.10	14,400	360.10	313.10	41,900
29-Apr-2010	5:00	504.90	450.90	15,800	445.08	393.28	19,200	385.41	361.91	14,200	360.10	313.10	41,900
29-Apr-2010	6:00	504.90	450.90	15,800	445.05	393.35	19,200	385.52	361.92	14,200	360.10	313.10	41,900
29-Apr-2010	7:00	504.88	450.88	15,800	445.05	393.35	19,200	385.65	361.85	14,000	360.10	313.20	42,200
29-Apr-2010	8:00	504.89	450.89	15,800	445.00	393.20	19,200	385.70	361.80	14,000	360.10	313.40	42,200
29-Apr-2010	9:00	504.89	450.89	15,800	445.05	392.25	19,200	385.55	362.75	21,600	360.10	313.40	42,200
29-Apr-2010	10:00	504.89	450.79	15,800	445.00	393.20	19,200	385.50	363.00	21,600	360.10	313.40	42,200
29-Apr-2010	11:00	504.89	450.79	15,800	444.95	394.15	21,900	385.50	363.20	21,600	360.10	313.40	42,200
29-Apr-2010	12:00	504.89	450.69	15,800	444.95	394.45	23,400	385.40	363.30	22,200	360.10	313.40	42,200
29-Apr-2010	13:00	504.90	450.80	15,800	444.90	394.80	23,700	385.40	363.40	22,200	360.10	313.40	42,200
29-Apr-2010	14:00	504.90	450.80	15,800	444.90	395.00	23,700	385.35	363.45	22,200	360.10	313.40	42,200
29-Apr-2010	15:00	504.92	450.92	15,800	444.90	395.00	23,700	385.30	363.40	22,200	360.10	313.40	42,200
29-Apr-2010	16:00	504.92	451.02	15,800	444.90	395.00	23,700	385.30	363.50	22,200	360.05	313.45	42,200
29-Apr-2010	17:00	504.92	451.02	15,800	444.85	395.15	23,700	385.30	363.60	22,200	360.05	313.55	42,200
29-Apr-2010	18:00	504.92	451.02	15,800	444.85	395.15	23,700	385.30	363.50	22,200	360.05	313.55	42,200
29-Apr-2010	19:00	504.85	452.65	24,800	444.80	395.30	23,700	385.35	363.45	22,200	360.05	313.65	42,500
29-Apr-2010	20:00	504.75	453.35	25,400	444.77	395.47	24,000	385.37	363.47	22,800	360.05	313.65	42,500
29-Apr-2010	21:00	504.75	453.55	25,400	444.75	395.45	24,000	385.40	363.50	22,800	360.00	313.80	42,500
29-Apr-2010	22:00	504.80	451.90	16,200	444.72	395.52	24,000	385.41	363.51	23,400	360.00	313.80	42,500
29-Apr-2010	23:00	504.80	451.40	16,200	444.71	395.51	24,000	385.46	363.56	22,800	359.95	313.85	42,500
29-Apr-2010	24:00:00	504.80	451.30	16,200	444.68	395.58	24,000	385.50	363.60	22,200	359.95	313.95	42,800
30-Apr-2010	1:00	504.80	451.20	15,800	444.68	395.58	24,000	385.54	363.64	22,800	359.95	314.05	42,800
30-Apr-2010	2:00	504.80	451.10	15,800	444.69	395.69	24,000	385.59	363.59	22,200	359.95	314.15	42,800

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010													
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Total Discharge cfs	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Total Discharge cfs	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Total Discharge cfs	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Total Discharge cfs
30-Apr-2010	3:00	504.80	451.00	15,800	444.68	395.68	24,000	385.62	363.52	22,800	359.95	314.25	42,800
30-Apr-2010	4:00	504.80	451.00	15,800	444.68	395.78	24,000	385.68	363.58	22,800	359.95	314.35	42,800
30-Apr-2010	5:00	504.82	450.92	15,800	444.67	395.77	24,000	385.73	363.53	22,200	359.95	314.35	42,800
30-Apr-2010	6:00	504.82	450.92	15,800	444.64	395.74	24,000	385.77	363.57	22,280	359.95	314.35	42,800
30-Apr-2010	7:00	504.82	450.82	15,800	444.60	395.80	24,000	385.80	363.60	22,280	359.95	314.45	43,100
30-Apr-2010	8:00	504.84	450.64	15,800	444.60	395.80	24,000	385.85	363.65	22,280	359.95	314.45	42,700
30-Apr-2010	9:00	504.84	450.54	15,800	444.55	396.05	24,300	385.90	363.60	22,900	359.95	314.45	42,700
30-Apr-2010	10:00	504.85	450.45	15,800	444.55	395.05	22,500	385.95	363.55	22,900	359.95	314.45	42,700
30-Apr-2010	11:00	504.85	450.38	15,700	444.55	395.15	21,300	386.00	363.50	22,400	359.95	314.45	42,700
30-Apr-2010	12:00	504.86	450.26	15,700	444.50	394.70	19,800	386.05	363.55	22,900	359.90	314.50	42,700
30-Apr-2010	13:00	504.86	450.16	15,600	444.50	394.60	19,800	385.80	364.30	28,600	359.90	314.60	42,800
30-Apr-2010	14:00	504.68	452.48	24,700	444.45	394.85	20,100	385.75	364.55	30,000	359.90	314.60	42,800
30-Apr-2010	15:00	504.69	452.79	24,700	444.50	394.30	19,800	385.60	364.90	29,100	359.90	314.60	42,800
30-Apr-2010	16:00	504.64	453.04	24,700	444.50	394.60	19,800	385.50	365.00	29,100	359.90	314.70	42,800
30-Apr-2010	17:00	504.57	453.37	25,300	444.45	394.15	19,500	385.40	365.00	29,100	359.85	314.75	42,600
30-Apr-2010	18:00	504.54	453.44	25,300	444.45	394.15	19,500	385.35	364.95	29,100	359.85	314.75	42,600
30-Apr-2010	19:00	504.50	453.60	25,300	444.42	394.42	19,800	385.13	365.13	27,900	359.80	314.80	42,600
30-Apr-2010	20:00	504.45	453.95	25,300	444.50	393.90	19,800	384.99	365.09	27,900	359.80	314.80	42,600
30-Apr-2010	21:00	504.35	454.25	25,900	444.52	393.82	19,500	384.88	365.08	29,100	359.80	314.80	42,600
30-Apr-2010	22:00	504.45	452.65	16,500	444.54	393.74	19,500	384.75	365.05	28,600	359.80	314.80	42,600
30-Apr-2010	23:00	504.45	452.35	16,500	444.55	393.75	19,500	384.62	365.12	27,500	359.75	314.85	42,800
30-Apr-2010	24:00:00	504.45	452.15	16,500	444.55	393.95	19,500	384.49	365.09	27,500	359.75	314.95	42,800
1-May-2010	1:00	504.50	451.80	16,200	444.55	394.95	23,700	384.36	365.06	28,700	359.75	315.05	42,500
1-May-2010	2:00	504.50	451.60	16,200	444.56	394.76	23,700	384.21	365.11	28,700	359.75	315.15	42,800
1-May-2010	3:00	504.45	451.45	16,200	444.60	394.90	23,700	384.07	365.07	26,700	359.75	315.25	42,800
1-May-2010	4:00	504.45	451.45	16,200	444.59	395.09	24,000	383.94	365.04	27,900	359.75	315.35	42,800

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010													
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Total Discharge cfs	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Total Discharge cfs	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Total Discharge cfs	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Total Discharge cfs
1-May-2010	5:00	504.50	451.30	16,200	444.59	395.09	24,000	383.79	365.09	27,900	359.70	315.40	43,100
1-May-2010	6:00	504.55	451.35	16,200	444.55	395.15	24,000	383.81	365.11	26,700	359.70	315.40	42,300
1-May-2010	7:00	504.50	451.40	16,200	444.58	395.38	24,900	383.77	365.27	28,200	359.85	315.55	41,900
1-May-2010	8:00	504.50	451.30	16,200	444.64	396.14	25,200	383.92	365.22	28,400	359.85	315.65	41,900
1-May-2010	9:00	504.54	451.34	16,200	444.65	396.65	24,000	384.14	365.24	26,700	359.90	316.00	42,200
1-May-2010	10:00	504.66	451.16	15,800	444.68	396.48	24,000	384.55	365.45	27,900	360.15	316.15	42,200
1-May-2010	11:00	504.42	453.02	25,400	444.74	396.54	24,000	385.00	365.70	27,900	360.15	316.25	42,200
1-May-2010	12:00	504.45	453.45	25,400	444.82	396.82	24,300	385.55	365.95	29,500	360.15	316.45	42,500
1-May-2010	13:00	504.47	453.77	25,400	444.85	398.25	30,000	386.00	367.00	39,600	360.25	316.55	42,500
1-May-2010	14:00	504.43	453.93	25,400	444.83	399.93	34,400	386.20	368.80	59,700	360.25	316.75	42,800
1-May-2010	15:00	504.50	454.30	26,000	444.94	400.84	36,100	386.08	371.28	92,700	360.25	316.75	42,800
1-May-2010	16:00	504.48	456.08	30,600	445.05	402.55	41,700	386.35	373.75	79,100	360.40	316.80	42,500
1-May-2010	17:00	504.70	457.50	32,400	445.20	404.80	47,600	386.31	375.71	78,000	360.55	316.95	42,600
1-May-2010	18:00	504.80	460.10	36,900	445.30	406.70	55,000	386.35	377.85	86,000	360.75	316.95	42,600
1-May-2010	19:00	504.89	462.79	42,700	445.60	408.30	54,200	385.65	380.95	102,000	360.95	316.95	42,300
1-May-2010	20:00	504.84	464.94	48,300	445.80	409.50	60,400	385.38	382.68	107,000	361.05	317.05	42,300
1-May-2010	21:00	504.97	466.37	48,300	445.90	410.50	65,200	385.95	384.15	114,000	361.25	317.05	42,100
1-May-2010	22:00	505.10	467.20	49,700	446.21	411.61	70,300	386.44	385.04	120,000	361.45	317.15	42,100
1-May-2010	23:00	505.25	467.95	47,100	446.33	412.13	69,700	386.82	385.62	122,000	361.60	317.30	42,100
1-May-2010	24:00:00	505.32	469.12	53,000	446.45	413.05	74,500	387.21	386.11	122,000	361.80	317.30	41,900
2-May-2010	1:00	505.25	470.45	61,600	446.80	414.80	75,400	387.82	386.92	126,000	362.00	317.50	41,900
2-May-2010	2:00	505.30	471.00	61,600	446.97	414.87	73,900	388.41	387.31	126,000	362.20	317.70	41,900
2-May-2010	3:00	505.35	471.35	60,900	447.20	414.90	74,400	388.90	387.90	130,000	362.50	318.00	42,000
2-May-2010	4:00	505.40	471.60	58,800	447.37	414.97	74,400	389.33	388.33	130,000	362.70	318.20	42,000
2-May-2010	5:00	505.42	471.82	57,800	447.57	415.07	74,800	389.73	388.73	133,000	362.90	318.50	42,300
2-May-2010	6:00	505.47	471.87	57,800	447.75	415.05	73,300	390.10	388.90	133,000	363.10	318.70	42,300

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010													
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Total Discharge cfs	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Total Discharge cfs	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Total Discharge cfs	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Total Discharge cfs
2-May-2010	7:00	505.47	472.07	59,400	447.88	415.68	81,100	390.50	389.40	137,000	363.25	318.85	42,400
2-May-2010	8:00	505.48	472.18	59,400	448.12	416.48	80,200	390.97	389.77	139,000	363.50	319.10	42,400
2-May-2010	9:00	505.47	472.17	59,400	448.78	418.08	80,200	391.60	390.30	142,000	363.65	319.15	42,100
2-May-2010	10:00	505.47	472.17	59,400	449.40	419.60	80,300	392.30	390.80	146,000	363.85	319.35	42,100
2-May-2010	11:00	505.42	472.22	58,800	449.80	421.10	89,700	393.00	391.40	148,000	364.05	319.95	48,500
2-May-2010	12:00	505.40	472.20	59,300	450.38	423.48	107,000	393.62	392.02	150,000	364.15	320.65	54,900
2-May-2010	13:00	505.36	472.16	58,800	450.91	425.21	123,600	394.30	393.30	160,000	364.30	321.30	59,600
2-May-2010	14:00	505.35	472.05	58,800	451.45	426.65	130,300	395.00	393.50	165,000	364.45	322.15	66,300
2-May-2010	15:00	505.42	472.22	58,800	451.45	428.85	142,900	395.62	393.92	170,000	364.55	323.15	74,600
2-May-2010	16:00	505.56	472.56	59,400	451.35	430.35	163,200	396.30	394.80	175,000	364.60	324.30	86,000
2-May-2010	17:00	505.87	473.27	58,500	451.26	431.86	202,850	396.86	395.36	175,000	364.65	325.35	93,300
2-May-2010	18:00	506.16	474.06	58,500	451.10	433.10	212,260	397.40	396.00	180,000	364.70	326.50	101,100
2-May-2010	19:00	506.50	474.80	60,600	451.00	433.50	211,730	397.80	396.40	185,000	364.75	328.15	110,200
2-May-2010	20:00	506.83	475.83	65,500	450.90	434.00	211,400	398.20	396.90	190,000	364.80	329.40	119,600
2-May-2010	21:00	507.17	476.47	65,600	450.80	434.50	211,070	398.60	397.40	195,000	364.85	330.65	130,400
2-May-2010	22:00	507.46	477.26	66,500	450.75	434.65	204,960	399.05	397.95	200,000	364.85	331.95	141,300
2-May-2010	23:00	507.80	478.10	74,500	450.80	434.70	199,025	399.45	398.35	200,000	364.85	333.05	150,500
2-May-2010	24:00:00	507.98	479.08	82,300	450.80	434.60	193,400	399.95	398.85	209,000	364.85	333.95	156,500
3-May-2010	1:00	508.25	480.35	94,000	450.80	434.20	187,620	400.48	399.38	220,000	364.85	335.05	166,700
3-May-2010	2:00	508.30	481.40	103,900	451.15	433.55	181,840	400.70	399.60	220,000	364.90	336.60	179,700
3-May-2010	3:00	508.21	482.81	113,100	451.25	433.05	182,820	401.14	400.04	220,000	364.85	337.35	187,900
3-May-2010	4:00	508.27	483.37	115,500	451.20	432.90	183,100	401.54	400.44	220,000	364.90	338.40	200,900
3-May-2010	5:00	508.33	483.83	119,000	450.95	433.55	194,600	401.85	400.75	220,000	364.85	339.35	209,900
3-May-2010	6:00	508.02	485.12	129,800	450.95	433.65	193,850	401.98	400.88	220,000	364.90	340.30	219,300
3-May-2010	7:00	508.05	485.35	130,100	450.55	434.25	196,748	402.48	401.38	220,000	364.95	341.25	227,900
3-May-2010	8:00	507.97	485.77	126,500	450.40	434.50	198,405	402.68	401.58	220,000	364.90	342.20	244,200

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010													
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Total Discharge cfs	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Total Discharge cfs	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Total Discharge cfs	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Total Discharge cfs
3-May-2010	9:00	507.91	486.01	125,400	450.30	434.60	197,940	402.89	401.79	220,000	364.90	343.20	251,900
3-May-2010	10:00	507.87	486.37	125,400	450.20	434.80	197,630	403.09	401.99	228,000	364.85	344.35	261,400
3-May-2010	11:00	507.80	486.50	124,900	450.10	434.90	197,320	403.29	402.19	228,000	364.90	344.80	260,700
3-May-2010	12:00	507.86	486.36	119,500	449.95	435.05	197,010	403.40	402.30	228,000	364.95	345.25	260,700
3-May-2010	13:00	507.90	486.10	113,400	449.80	435.20	196,545	403.54	402.54	228,000	364.95	345.85	270,900
3-May-2010	14:00	507.88	486.18	113,900	449.70	434.90	190,400	403.66	402.66	230,000	364.95	346.45	279,000
3-May-2010	15:00	507.92	486.02	110,000	449.65	434.55	175,925	403.78	402.78	231,000	364.95	347.15	289,200
3-May-2010	16:00	507.86	485.96	110,800	449.80	434.00	165,402	403.89	402.99	232,000	364.85	347.85	299,700
3-May-2010	17:00	507.88	485.78	107,000	449.90	433.00	156,320	403.94	403.04	232,000	364.90	348.40	300,000
3-May-2010	18:00	507.95	485.45	100,200	450.00	432.60	150,183	403.99	403.09	232,000	364.90	348.70	300,000
3-May-2010	19:00	507.93	485.13	100,800	450.10	432.28	144,235	404.05	403.15	234,000	364.95	349.25	300,000
3-May-2010	20:00	507.92	484.82	98,200	450.20	431.70	144,450	404.05	403.05	234,000	365.10	349.10	291,200
3-May-2010	21:00	507.93	484.33	95,300	450.30	431.50	144,670	404.10	403.10	234,000	365.15	348.95	280,800
3-May-2010	22:00	507.91	484.01	92,600	450.40	431.20	144,885	404.15	403.15	240,000	365.25	349.05	282,400
3-May-2010	23:00	507.90	483.50	89,700	450.50	431.00	145,100	404.15	403.25	240,000	365.25	349.15	282,400
3-May-2010	24:00:00	507.90	483.30	86,100	450.55	430.85	145,210	404.15	403.25	240,000	365.25	349.25	282,400
4-May-2010	1:00	507.89	482.59	83,500	450.60	430.80	145,315	404.15	403.25	240,000	365.30	349.30	282,400
4-May-2010	2:00	507.88	481.88	78,400	450.65	430.65	145,425	404.15	403.25	240,000	365.35	349.45	283,200
4-May-2010	3:00	507.88	481.38	74,300	450.70	430.50	145,530	404.15	403.25	240,000	365.45	349.55	283,200
4-May-2010	4:00	507.93	480.53	70,600	450.70	430.40	145,530	404.10	403.20	240,000	365.45	349.65	283,200
4-May-2010	5:00	507.88	479.98	70,400	450.75	430.35	145,640	404.05	403.15	240,000	365.45	350.05	293,600
4-May-2010	6:00	507.86	479.56	89,000	450.80	430.40	145,750	404.05	403.15	240,000	365.45	350.05	293,600
4-May-2010	7:00	507.75	479.05	65,200	450.84	430.24	145,835	403.95	403.15	235,000	365.50	350.40	296,000
4-May-2010	8:00	507.62	478.62	67,400	450.86	430.26	145,880	403.91	403.11	235,000	365.45	350.75	303,200
4-May-2010	9:00	507.49	478.39	65,600	450.85	429.95	145,855	403.85	403.05	235,000	365.60	350.60	285,800
4-May-2010	10:00	507.31	477.91	70,100	450.85	430.05	145,855	403.75	402.85	235,000	365.70	350.40	266,000

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010													
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Total Discharge cfs	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Total Discharge cfs	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Total Discharge cfs	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Total Discharge cfs
4-May-2010	11:00	507.12	477.62	68,900	450.85	429.95	145,855	403.70	402.80	235,000	365.70	350.30	266,000
4-May-2010	12:00	506.92	477.32	68,000	450.85	429.95	145,855	403.70	402.80	235,000	365.70	350.30	266,000
4-May-2010	13:00	506.72	477.12	66,400	450.85	429.85	145,855	403.60	402.70	235,000	365.80	350.40	266,000
4-May-2010	14:00	506.47	476.77	69,900	450.85	429.85	145,855	403.52	402.62	235,000	365.80	350.40	266,000
4-May-2010	15:00	506.24	476.44	66,200	450.80	429.90	145,750	403.45	402.55	235,000	365.80	350.40	266,700
4-May-2010	16:00	505.98	476.18	67,100	450.75	429.75	145,640	403.35	402.65	235,000	365.85	350.35	266,700
4-May-2010	17:00	505.90	475.50	64,700	450.75	429.75	145,640	403.30	402.60	235,000	366.05	349.75	249,300
4-May-2010	18:00	505.68	474.98	56,800	450.65	429.65	145,425	403.20	402.50	235,000	366.10	349.50	229,800
4-May-2010	19:00	505.52	474.02	51,800	450.58	429.78	145,275	403.09	402.39	230,000	366.15	349.25	230,400
4-May-2010	20:00	505.32	473.62	53,400	450.53	429.73	145,165	402.96	402.36	230,000	366.15	349.15	230,400
4-May-2010	21:00	505.18	472.78	51,800	450.48	429.58	145,055	402.85	402.25	230,000	366.25	349.05	231,000
4-May-2010	22:00	505.03	472.33	46,500	450.39	429.59	144,860	402.74	402.14	225,000	366.25	349.05	231,000
4-May-2010	23:00	504.95	471.45	42,500	450.30	429.50	144,670	402.63	402.03	225,000	366.30	349.00	231,000
4-May-2010	24:00:00	504.92	470.22	35,500	450.20	429.40	144,450	402.52	401.92	225,000	366.35	348.95	231,000
5-May-2010	1:00	504.74	469.64	38,800	450.12	429.52	144,280	402.42	401.82	220,000	366.35	348.85	231,000
5-May-2010	2:00	504.54	468.84	38,400	450.00	429.40	144,020	402.30	401.70	220,000	366.40	348.80	231,000
5-May-2010	3:00	504.50	468.10	34,400	449.90	429.30	143,805	402.15	401.55	220,000	366.45	348.75	231,600
5-May-2010	4:00	504.39	467.49	29,700	449.84	429.24	143,675	402.07	401.47	220,000	366.50	348.70	231,600
5-May-2010	5:00	504.30	466.70	31,500	449.70	429.20	143,370	401.96	401.36	217,000	366.50	348.70	231,600
5-May-2010	6:00	504.19	466.29	28,600	449.58	429.28	143,115	401.86	401.26	217,000	366.55	348.65	232,200
5-May-2010	7:00	504.03	465.73	30,400	449.40	429.10	142,720	401.75	401.15	217,000	366.60	348.70	232,200
5-May-2010	8:00	503.86	465.36	31,800	449.27	429.17	142,440	401.62	401.02	217,000	366.60	348.70	232,200
5-May-2010	9:00	503.73	464.93	33,000	449.09	429.09	142,045	401.50	401.00	215,000	366.65	348.65	232,200
5-May-2010	10:00	503.58	464.58	33,400	449.00	429.00	129,200	401.35	400.75	212,000	366.65	348.65	232,200
5-May-2010	11:00	503.26	464.06	46,300	448.65	429.25	134,405	401.25	400.65	212,000	366.70	348.60	232,200
5-May-2010	12:00	503.28	484.38	45,900	448.50	428.91	134,150	401.13	400.53	212,000	366.70	348.60	232,200

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010													
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Total Discharge cfs	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Total Discharge cfs	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Total Discharge cfs	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Total Discharge cfs
5-May-2010	13:00	502.90	464.50	44,400	448.30	428.60	121,550	401.00	400.40	206,000	366.75	348.55	232,200
5-May-2010	14:00	503.50	461.30	22,000	448.25	428.15	120,975	400.85	400.35	206,000	366.80	348.60	232,800
5-May-2010	15:00	503.50	459.60	10,000	448.05	427.85	108,965	400.75	400.15	206,000	366.85	348.55	232,800
5-May-2010	16:00	503.40	458.50	9,700	448.00	427.30	108,900	400.60	400.00	206,000	366.85	348.55	232,800
5-May-2010	17:00	503.42	457.32	10,100	448.05	426.45	99,000	400.45	399.95	206,000	366.90	348.60	232,800
5-May-2010	18:00	503.51	457.41	9,500	447.95	426.45	98,800	400.40	399.80	206,000	366.90	348.60	232,800
5-May-2010	19:00	503.60	455.80	9,100	447.84	426.44	94,000	400.20	399.60	200,000	366.95	348.65	233,400
5-May-2010	20:00	503.65	455.25	9,100	447.79	425.09	89,500	400.00	399.40	195,000	366.95	348.65	233,400
5-May-2010	21:00	503.70	454.90	8,900	447.70	424.60	89,200	399.83	399.23	190,000	366.95	348.65	233,400
5-May-2010	22:00	503.77	454.37	8,900	447.55	424.25	86,900	399.68	399.08	190,000	366.95	348.65	233,400
5-May-2010	23:00	503.85	454.15	8,700	447.40	423.60	83,200	399.50	398.90	190,000	367.00	348.70	233,400
5-May-2010	24:00:00	503.90	453.90	8,700	447.30	422.90	79,400	399.33	398.73	190,000	367.00	348.70	233,400
6-May-2010	1:00	503.95	453.65	8,700	447.20	422.40	75,800	399.09	398.59	190,000	367.00	348.70	233,400
6-May-2010	2:00	504.03	453.53	8,500	447.13	421.53	70,400	398.90	398.40	187,000	367.00	348.70	233,400
6-May-2010	3:00	503.90	455.00	17,700	447.00	421.10	70,400	398.72	398.22	187,000	367.00	348.70	233,400
6-May-2010	4:00	503.97	455.37	17,700	446.85	420.05	65,500	398.52	398.02	184,000	367.00	348.70	233,400
6-May-2010	5:00	504.02	455.52	17,700	446.73	419.33	61,500	398.32	397.82	184,000	367.00	348.70	233,400
6-May-2010	6:00	503.93	455.63	18,200	446.60	418.90	62,400	398.12	397.62	182,000	367.00	348.70	233,400
6-May-2010	7:00	503.90	455.70	18,200	446.45	418.05	63,100	397.92	397.32	182,000	367.00	348.70	233,400
6-May-2010	8:00	504.01	455.71	18,200	446.35	417.65	63,100	397.70	397.10	182,000	367.00	348.80	233,400
6-May-2010	9:00	504.03	455.83	18,200	446.23	417.33	63,800	397.49	396.99	179,000	367.05	348.85	233,400
6-May-2010	10:00	504.03	455.83	18,200	446.12	416.92	63,800	397.27	396.77	176,000	367.05	348.85	233,400
6-May-2010	11:00	504.05	455.85	18,200	445.99	416.49	63,900	397.05	396.55	173,000	367.15	348.65	226,800
6-May-2010	12:00	504.06	455.96	18,200	445.88	416.18	65,200	396.76	396.26	172,000	367.15	348.25	219,000
6-May-2010	13:00	503.81	458.01	28,500	445.77	415.37	61,200	396.53	396.03	168,000	367.25	348.25	219,000
6-May-2010	14:00	503.85	458.55	29,300	445.72	414.72	54,500	396.29	395.79	167,000	367.45	347.45	207,900

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010													
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Total Discharge cfs	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Total Discharge cfs	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Total Discharge cfs	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Total Discharge cfs
6-May-2010	15:00	503.80	459.00	29,300	445.63	414.23	55,700	396.02	395.52	166,000	367.55	347.35	198,600
6-May-2010	16:00	503.73	459.33	30,000	445.55	413.75	55,600	395.77	395.17	163,000	367.65	347.15	187,900
6-May-2010	17:00	503.90	457.60	19,000	445.50	413.40	56,100	395.51	395.01	160,000	367.75	346.55	177,500
6-May-2010	18:00	503.95	457.25	18,600	445.40	413.10	55,600	395.24	394.84	159,000	367.75	345.95	165,400
6-May-2010	19:00	503.88	456.98	18,600	445.29	412.69	56,500	394.94	394.44	155,000	368.00	345.00	158,400
6-May-2010	20:00	503.96	456.76	18,600	445.26	412.46	57,100	394.69	394.19	155,000	368.05	344.65	150,400
6-May-2010	21:00	504.05	456.55	18,200	445.17	412.07	57,100	394.42	393.92	151,000	368.15	344.35	150,600
6-May-2010	22:00	504.08	456.38	18,200	445.11	411.91	55,600	394.14	393.64	147,000	368.20	343.80	150,800
6-May-2010	23:00	504.11	456.41	18,200	445.06	411.76	56,200	393.86	393.36	145,000	368.30	343.60	151,000
6-May-2010	24:00:00	504.18	456.28	18,200	444.99	411.59	56,200	393.57	393.07	145,000	368.30	343.60	151,000
7-May-2010	1:00	504.02	458.22	28,500	444.91	411.41	54,900	393.28	392.78	141,000	368.40	343.00	151,200
7-May-2010	2:00	503.99	458.79	29,300	444.82	411.22	54,900	393.00	392.50	140,000	368.45	342.65	151,200
7-May-2010	3:00	503.99	459.19	29,300	444.76	411.06	56,100	392.75	392.25	140,000	368.50	342.30	151,600
7-May-2010	4:00	503.94	459.64	30,000	444.69	410.99	56,500	392.47	391.97	136,000	368.55	342.15	151,600
7-May-2010	5:00	503.88	459.78	30,000	444.64	410.44	52,100	392.15	391.65	132,000	368.60	341.90	151,800
7-May-2010	6:00	503.84	460.04	30,000	444.60	410.20	51,900	391.87	391.47	130,000	368.65	341.85	151,800

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010									
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Total Discharge cfs	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Total Discharge cfs	Center Hill Dam Headwater Elevation ft	Center Hill Dam Total Discharge cfs	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Total Discharge cfs
29-Apr-2010	1:00	683.33	14,560	650.32	1,745	630.44	250	489.31	0
29-Apr-2010	2:00	683.33	14,560	650.32	1,745	630.44	250	489.31	0
29-Apr-2010	3:00	683.35	14,560	650.32	1,745	630.44	250	489.32	0
29-Apr-2010	4:00	683.35	14,560	650.32	1,745	630.45	250	489.32	0
29-Apr-2010	5:00	683.35	14,560	650.32	1,745	630.45	250	489.32	0
29-Apr-2010	6:00	683.35	14,560	650.32	1,745	630.45	3,650	489.32	0
29-Apr-2010	7:00	683.34	14,560	650.31	1,795	630.46	3,650	489.33	0
29-Apr-2010	8:00	683.34	10,930	650.31	1,795	630.45	3,650	489.33	0
29-Apr-2010	9:00	683.33	10,840	650.30	1,795	630.45	3,650	489.33	0
29-Apr-2010	10:00	683.33	10,840	650.30	1,795	630.43	3,650	489.33	0
29-Apr-2010	11:00	683.32	10,840	650.30	1,745	630.43	250	489.33	0
29-Apr-2010	12:00	683.32	10,780	650.30	1,745	630.43	250	489.33	0
29-Apr-2010	13:00	683.31	14,480	650.29	1,745	630.43	250	489.34	0
29-Apr-2010	14:00	683.31	14,560	650.29	1,745	630.43	250	489.34	0
29-Apr-2010	15:00	683.31	14,560	650.28	1,745	630.43	3,650	489.34	0
29-Apr-2010	16:00	683.31	14,560	650.28	1,745	630.43	3,650	489.34	0
29-Apr-2010	17:00	683.31	14,560	650.28	1,745	630.42	3,650	489.34	0
29-Apr-2010	18:00	683.31	14,560	650.27	1,745	630.41	3,650	489.34	0
29-Apr-2010	19:00	683.31	14,560	650.27	1,745	630.40	3,650	489.34	0
29-Apr-2010	20:00	683.31	14,560	650.27	1,745	630.40	3,650	489.34	0
29-Apr-2010	21:00	683.31	14,560	650.27	1,745	630.40	3,650	489.34	0
29-Apr-2010	22:00	683.31	14,560	650.27	1,745	630.40	250	489.34	0
29-Apr-2010	23:00	683.31	14,560	650.27	1,745	630.40	250	489.34	0
29-Apr-2010	24:00:00	683.31	14,560	650.26	1,745	630.40	250	489.34	0
30-Apr-2010	1:00	683.29	14,560	650.26	1,745	630.42	250	489.34	0
30-Apr-2010	2:00	683.27	14,560	650.26	1,745	630.42	250	489.34	0
30-Apr-2010	3:00	683.26	14,560	650.25	1,745	630.42	250	489.34	0

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010									
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Total Discharge cfs	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Total Discharge cfs	Center Hill Dam Headwater Elevation ft	Center Hill Dam Total Discharge cfs	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Total Discharge cfs
30-Apr-2010	4:00	683.25	14,560	650.25	1,745	630.42	250	489.34	0
30-Apr-2010	5:00	683.25	14,560	650.25	1,745	630.42	250	489.35	0
30-Apr-2010	6:00	683.25	14,560	650.25	1,745	630.42	250	489.35	0
30-Apr-2010	7:00	683.23	14,680	650.24	1,745	630.44	250	489.36	0
30-Apr-2010	8:00	683.22	14,680	650.24	1,745	630.44	250	489.36	0
30-Apr-2010	9:00	683.21	14,680	650.23	1,745	630.44	250	489.36	0
30-Apr-2010	10:00	683.19	14,680	650.22	1,745	630.46	250	489.36	0
30-Apr-2010	11:00	683.17	14,680	650.22	1,745	630.46	3,650	489.35	0
30-Apr-2010	12:00	683.15	14,680	650.21	1,745	630.45	3,650	489.35	0
30-Apr-2010	13:00	683.13	14,680	650.21	1,745	630.45	3,650	489.35	0
30-Apr-2010	14:00	683.12	14,680	650.20	1,745	630.44	3,650	489.35	0
30-Apr-2010	15:00	683.11	14,680	650.20	1,745	630.43	3,650	489.35	0
30-Apr-2010	16:00	683.10	14,680	650.19	1,745	630.43	3,650	489.35	0
30-Apr-2010	17:00	683.08	14,680	650.19	1,745	630.42	3,650	489.35	0
30-Apr-2010	18:00	683.06	14,680	650.19	1,745	630.42	3,650	489.35	0
30-Apr-2010	19:00	683.06	14,680	650.19	1,745	630.41	3,650	489.35	0
30-Apr-2010	20:00	683.05	14,680	650.18	1,745	630.41	3,650	489.35	0
30-Apr-2010	21:00	683.03	14,680	650.18	1,745	630.41	3,650	489.35	0
30-Apr-2010	22:00	683.01	14,680	650.18	1,745	630.41	3,650	489.35	0
30-Apr-2010	23:00	683.01	14,680	650.18	1,745	630.41	250	489.35	0
30-Apr-2010	24:00:00	682.99	14,680	650.17	1,745	630.41	250	489.35	0
1-May-2010	1:00	682.99	14,680	650.17	1,745	630.42	250	489.36	0
1-May-2010	2:00	682.99	14,680	650.17	1,745	630.42	250	489.36	0
1-May-2010	3:00	682.99	14,680	650.17	1,745	630.44	250	489.36	0
1-May-2010	4:00	682.98	14,680	650.16	1,770	630.44	250	489.36	0
1-May-2010	5:00	682.96	14,680	650.16	1,795	630.44	250	489.36	0
1-May-2010	6:00	682.94	14,680	650.16	1,795	630.44	250	489.36	0

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010									
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Total Discharge cfs	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Total Discharge cfs	Center Hill Dam Headwater Elevation ft	Center Hill Dam Total Discharge cfs	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Total Discharge cfs
1-May-2010	7:00	682.92	14,680	650.15	1,795	630.46	250	489.37	0
1-May-2010	8:00	682.88	14,680	650.14	1,795	630.46	250	489.40	0
1-May-2010	9:00	682.92	14,680	650.14	1,795	630.46	250	489.45	0
1-May-2010	10:00	682.92	14,680	650.14	1,795	630.46	250	489.47	0
1-May-2010	11:00	682.88	14,680	650.15	1,795	630.58	3,650	489.48	4,600
1-May-2010	12:00	682.88	14,680	650.16	1,795	630.61	3,650	489.50	4,600
1-May-2010	13:00	682.98	14,680	650.18	1,795	630.65	3,650	489.60	4,600
1-May-2010	14:00	682.98	14,680	650.18	1,795	630.61	3,650	489.68	4,600
1-May-2010	15:00	682.89	14,680	650.20	1,795	630.65	3,650	489.84	4,600
1-May-2010	16:00	682.89	14,680	650.22	1,795	630.65	3,650	490.00	4,700
1-May-2010	17:00	683.01	14,680	650.24	1,815	630.70	3,750	490.30	4,700
1-May-2010	18:00	683.06	14,680	650.35	1,825	630.73	3,750	490.45	4,700
1-May-2010	19:00	683.15	14,680	650.45	1,845	630.85	3,750	490.95	4,800
1-May-2010	20:00	683.15	14,680	650.59	1,855	631.07	3,750	491.43	4,800
1-May-2010	21:00	683.20	14,680	650.71	1,855	631.15	3,750	491.93	4,800
1-May-2010	22:00	683.20	14,680	650.83	1,875	631.15	3,750	492.43	4,800
1-May-2010	23:00	683.30	14,680	650.97	1,235	631.25	3,750	492.95	4,800
1-May-2010	24:00:00	683.35	14,680	651.07	1,145	631.33	3,750	493.55	4,800
2-May-2010	1:00	683.61	14,680	651.20	1,335	631.35	3,750	494.68	4,800
2-May-2010	2:00	683.82	14,680	651.31	1,885	631.35	3,750	494.97	4,800
2-May-2010	3:00	684.04	14,680	651.42	1,885	631.40	3,750	495.26	4,800
2-May-2010	4:00	684.21	14,680	651.53	1,885	631.45	3,750	495.49	4,800
2-May-2010	5:00	684.36	14,680	651.62	1,885	631.50	3,750	495.71	4,800
2-May-2010	6:00	684.50	14,680	651.72	1,885	631.70	3,750	495.91	4,800
2-May-2010	7:00	684.55	14,680	651.78	1,885	631.94	3,750	496.11	4,800
2-May-2010	8:00	684.70	14,560	651.86	1,875	632.20	3,750	496.25	4,800
2-May-2010	9:00	684.76	14,560	651.91	1,875	632.48	3,750	496.40	4,900

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010									
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Total Discharge cfs	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Total Discharge cfs	Center Hill Dam Headwater Elevation ft	Center Hill Dam Total Discharge cfs	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Total Discharge cfs
2-May-2010	10:00	684.94	14,560	651.99	1,875	632.75	3,750	496.67	4,900
2-May-2010	11:00	685.02	14,560	652.03	1,875	633.01	3,750	496.87	4,900
2-May-2010	12:00	685.15	14,560	652.07	1,875	633.24	3,750	497.07	5,000
2-May-2010	13:00	685.33	14,560	652.14	1,825	633.50	3,650	497.10	5,000
2-May-2010	14:00	685.50	14,560	652.18	1,825	633.93	3,650	497.30	5,000
2-May-2010	15:00	685.72	14,560	652.22	1,835	633.99	3,650	497.47	5,000
2-May-2010	16:00	685.90	14,560	652.27	1,845	634.17	3,650	497.70	5,000
2-May-2010	17:00	686.24	14,560	652.39	1,905	634.39	3,650	497.80	5,000
2-May-2010	18:00	686.75	14,560	652.52	1,965	634.64	3,650	497.95	5,000
2-May-2010	19:00	687.25	14,800	652.79	1,985	634.93	3,650	498.05	5,200
2-May-2010	20:00	687.62	14,800	653.15	2,005	635.16	3,650	498.17	5,200
2-May-2010	21:00	688.13	14,880	653.47	1,775	635.46	3,650	498.29	5,200
2-May-2010	22:00	688.60	14,880	653.73	1,775	635.80	250	498.46	0
2-May-2010	23:00	689.11	14,800	653.87	1,775	636.12	250	498.61	0
2-May-2010	24:00:00	689.54	7,480	654.12	75	636.51	250	498.71	0
3-May-2010	1:00	689.93	280	654.36	75	636.89	250	498.98	0
3-May-2010	2:00	690.40	280	654.59	75	637.24	250	499.06	0
3-May-2010	3:00	690.83	280	654.78	75	637.54	250	499.22	0
3-May-2010	4:00	691.25	280	654.94	75	637.82	250	499.36	0
3-May-2010	5:00	691.72	280	655.10	75	638.11	250	499.48	0
3-May-2010	6:00	692.14	280	655.34	75	638.38	250	499.56	0
3-May-2010	7:00	692.63	280	655.47	75	638.66	250	499.72	0
3-May-2010	8:00	693.00	280	655.62	75	638.92	250	502.00	3,900
3-May-2010	9:00	693.36	280	655.77	75	639.21	250	502.25	5,100
3-May-2010	10:00	693.82	280	655.90	75	639.49	250	502.50	5,200
3-May-2010	11:00	694.20	280	656.01	75	639.78	250	502.60	5,200
3-May-2010	12:00	694.54	280	656.12	75	640.06	250	502.60	5,200

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010									
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Total Discharge cfs	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Total Discharge cfs	Center Hill Dam Headwater Elevation ft	Center Hill Dam Total Discharge cfs	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Total Discharge cfs
3-May-2010	13:00	694.88	280	656.26	75	640.36	250	502.80	5,200
3-May-2010	14:00	695.30	280	656.37	75	640.60	250	503.00	5,200
3-May-2010	15:00	695.66	280	656.39	75	640.93	250	503.30	5,200
3-May-2010	16:00	695.85	280	656.44	1,965	641.21	250	503.50	5,200
3-May-2010	17:00	696.18	280	656.50	1,945	641.52	250	503.80	5,200
3-May-2010	18:00	696.40	280	656.55	1,715	641.78	250	504.01	5,200
3-May-2010	19:00	696.78	280	656.59	1,715	642.07	250	504.20	5,100
3-May-2010	20:00	697.15	280	656.63	1,695	642.28	250	504.18	5,100
3-May-2010	21:00	697.46	280	656.71	1,685	642.60	250	504.25	5,100
3-May-2010	22:00	697.78	280	656.71	1,685	642.83	250	504.30	5,100
3-May-2010	23:00	698.02	280	656.74	1,675	643.08	250	504.35	5,000
3-May-2010	24:00:00	698.37	280	656.78	1,675	643.30	250	504.35	6,000
4-May-2010	1:00	698.54	7,180	656.81	1,655	643.54	3,450	504.40	7,000
4-May-2010	2:00	698.76	7,240	656.83	1,655	643.75	3,450	504.40	7,000
4-May-2010	3:00	698.98	7,240	656.86	1,655	643.95	3,450	504.40	7,000
4-May-2010	4:00	699.22	7,240	656.89	1,645	644.14	3,450	504.40	7,000
4-May-2010	5:00	699.44	7,240	656.92	1,645	644.31	3,450	504.42	7,000
4-May-2010	6:00	699.64	7,240	656.94	1,625	644.48	3,450	504.42	7,000
4-May-2010	7:00	699.87	7,240	656.97	1,625	644.63	3,450	504.54	7,000
4-May-2010	8:00	700.10	7,180	656.98	1,565	644.78	3,450	504.60	7,000
4-May-2010	9:00	700.16	7,180	657.00	1,565	644.92	3,450	504.90	8,600
4-May-2010	10:00	700.29	7,180	657.02	1,555	645.07	3,350	504.90	8,600
4-May-2010	11:00	700.48	7,180	657.04	1,545	645.17	3,350	504.90	8,600
4-May-2010	12:00	700.67	7,180	657.06	1,545	645.30	3,350	504.90	8,600
4-May-2010	13:00	700.79	10,720	657.07	1,535	645.40	3,350	504.90	8,600
4-May-2010	14:00	700.95	10,780	657.09	1,525	645.49	3,350	504.90	8,600
4-May-2010	15:00	701.12	10,780	657.10	1,525	645.47	3,350	504.90	8,600

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010									
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Total Discharge cfs	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Total Discharge cfs	Center Hill Dam Headwater Elevation ft	Center Hill Dam Total Discharge cfs	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Total Discharge cfs
4-May-2010	16:00	701.24	10,780	657.12	1,525	645.56	3,350	504.90	8,600
4-May-2010	17:00	701.36	10,720	657.13	1,575	645.66	3,350	504.90	8,600
4-May-2010	18:00	701.47	10,720	657.14	1,515	645.70	3,350	504.90	8,600
4-May-2010	19:00	701.59	10,720	657.16	1,515	645.73	3,350	504.85	8,600
4-May-2010	20:00	701.71	10,720	657.17	1,505	645.85	3,350	504.80	8,600
4-May-2010	21:00	701.82	10,720	657.18	1,505	645.91	3,350	504.68	8,600
4-May-2010	22:00	701.93	10,720	657.20	1,505	645.95	3,350	504.55	8,600
4-May-2010	23:00	702.04	10,720	657.21	1,495	646.02	3,350	504.48	8,600
4-May-2010	24:00:00	702.15	10,720	657.22	1,495	646.11	3,350	504.40	8,600
5-May-2010	1:00	702.22	10,720	657.23	1,495	646.15	3,350	504.40	8,600
5-May-2010	2:00	702.30	10,720	657.24	1,495	646.19	3,350	504.40	8,600
5-May-2010	3:00	702.38	10,720	657.25	1,495	646.27	3,350	504.40	8,600
5-May-2010	4:00	702.46	10,720	657.26	1,495	646.34	3,350	504.40	8,600
5-May-2010	5:00	702.53	10,720	657.27	1,495	646.37	3,350	504.39	8,600
5-May-2010	6:00	702.60	10,720	657.28	2,965	646.43	3,350	504.39	8,600
5-May-2010	7:00	702.65	10,720	657.28	2,965	646.50	3,350	504.70	8,600
5-May-2010	8:00	702.72	10,720	657.30	1,495	646.54	3,350	504.62	8,600
5-May-2010	9:00	702.78	10,720	657.31	1,495	646.58	3,350	504.61	8,600
5-May-2010	10:00	702.84	10,720	657.31	1,495	646.63	3,350	504.60	8,600
5-May-2010	11:00	702.90	10,720	657.32	1,495	646.68	3,350	504.59	8,600
5-May-2010	12:00	702.96	10,630	657.32	1,495	646.72	3,350	504.58	8,600
5-May-2010	13:00	702.98	17,780	657.32	2,985	646.75	5,950	504.57	8,600
5-May-2010	14:00	703.02	20,730	657.32	3,005	646.76	6,450	504.56	8,600
5-May-2010	15:00	703.08	20,930	657.33	3,005	646.71	12,250	504.55	8,600
5-May-2010	16:00	703.14	20,930	657.33	3,005	646.70	11,650	504.55	8,600
5-May-2010	17:00	703.16	20,930	657.33	3,005	646.70	11,850	504.55	8,600
5-May-2010	18:00	703.20	20,930	657.33	2,995	646.65	12,450	504.55	8,600

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010									
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Total Discharge cfs	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Total Discharge cfs	Center Hill Dam Headwater Elevation ft	Center Hill Dam Total Discharge cfs	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Total Discharge cfs
5-May-2010	19:00	703.23	21,180	657.33	2,995	646.60	11,950	504.60	8,600
5-May-2010	20:00	703.25	21,180	657.34	2,995	646.60	12,650	504.60	8,600
5-May-2010	21:00	703.28	21,180	657.34	2,995	646.57	12,650	504.59	8,600
5-May-2010	22:00	703.31	21,180	657.34	2,985	646.53	12,650	504.58	8,500
5-May-2010	23:00	703.34	21,180	657.34	2,985	646.50	12,950	504.57	8,500
5-May-2010	24:00:00	703.37	21,180	657.34	2,985	646.48	12,950	504.56	8,500
6-May-2010	1:00	703.40	21,180	657.31	3,365	646.44	12,850	504.55	8,500
6-May-2010	2:00	703.43	21,180	657.31	3,365	646.41	12,850	504.54	8,500
6-May-2010	3:00	703.46	21,180	657.30	3,365	646.38	12,950	504.53	8,500
6-May-2010	4:00	703.49	21,180	657.30	3,365	646.35	12,950	504.52	8,500
6-May-2010	5:00	703.51	21,180	657.29	3,365	646.31	13,050	504.50	8,500
6-May-2010	6:00	703.54	21,180	657.29	3,365	646.28	13,050	504.49	8,500
6-May-2010	7:00	703.56	21,180	657.28	3,365	646.25	12,650	504.29	8,400
6-May-2010	8:00	703.58	21,180	657.28	3,365	646.22	13,350	504.28	8,400
6-May-2010	9:00	703.62	21,180	657.34	3,325	646.17	12,850	504.26	8,400
6-May-2010	10:00	703.66	21,180	657.34	3,345	646.15	12,650	504.25	8,400
6-May-2010	11:00	703.66	24,300	657.34	3,345	646.13	13,250	504.24	8,400
6-May-2010	12:00	703.66	24,300	657.34	3,345	646.10	13,150	504.23	8,400
6-May-2010	13:00	703.66	24,300	657.34	3,345	646.08	13,900	504.22	8,300
6-May-2010	14:00	703.66	24,300	657.34	3,345	646.03	16,500	504.21	8,300
6-May-2010	15:00	703.70	24,300	657.33	3,345	645.98	16,000	504.20	8,300
6-May-2010	16:00	703.70	24,300	657.33	3,345	645.94	16,000	504.19	8,300
6-May-2010	17:00	703.70	24,300	657.33	3,345	645.90	16,300	504.17	8,300
6-May-2010	18:00	703.70	24,300	657.33	3,345	645.91	16,000	504.16	8,300
6-May-2010	19:00	703.73	24,300	657.32	3,345	645.82	16,100	504.00	8,300
6-May-2010	20:00	703.76	24,300	657.32	3,345	645.79	15,900	503.98	8,300
6-May-2010	21:00	703.79	24,300	657.32	3,345	645.75	16,100	503.98	8,300

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Cumberland River Basin Projects Hourly Water Control Data -> 29 April - 07 May 2010									
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Total Discharge cfs	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Total Discharge cfs	Center Hill Dam Headwater Elevation ft	Center Hill Dam Total Discharge cfs	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Total Discharge cfs
6-May-2010	22:00	703.81	24,300	657.32	3,365	645.71	16,100	503.97	8,300
6-May-2010	23:00	703.83	24,300	657.32	3,365	645.67	16,000	503.95	8,300
6-May-2010	24:00:00	703.86	24,300	657.32	3,365	645.63	16,000	503.92	8,300
7-May-2010	1:00	703.84	25,450	657.31	3,365	645.58	16,000	503.90	8,300
7-May-2010	2:00	703.82	25,450	657.31	3,365	645.54	16,000	503.89	8,300
7-May-2010	3:00	703.79	25,450	657.30	3,365	645.50	15,900	503.88	8,300
7-May-2010	4:00	703.76	25,450	657.30	3,365	645.46	15,900	503.87	8,300
7-May-2010	5:00	703.76	25,450	657.29	3,365	645.41	16,000	503.82	8,200
7-May-2010	6:00	703.75	25,450	657.29	3,365	645.37	16,000	503.77	8,200

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Wolf Creek Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Tailwater Elevation ft	Wolf Creek Dam Turbine Discharge cfs	Wolf Creek Dam Gate Release cfs	Wolf Creek Dam Total Discharge cfs	Wolf Creek Dam Gross Energy mwh
29-Apr-2010	1:00	683.33	556.63	14,280	280	14,560	140
29-Apr-2010	2:00	683.33	556.63	14,280	280	14,560	140
29-Apr-2010	3:00	683.35	556.65	14,280	280	14,560	140
29-Apr-2010	4:00	683.35	556.65	14,280	280	14,560	140
29-Apr-2010	5:00	683.35	556.65	14,280	280	14,560	140
29-Apr-2010	6:00	683.35	556.65	14,280	280	14,560	140
29-Apr-2010	7:00	683.34	556.64	14,280	280	14,560	140
29-Apr-2010	8:00	683.34	555.34	10,650	280	10,930	105
29-Apr-2010	9:00	683.33	554.83	10,560	280	10,840	105
29-Apr-2010	10:00	683.33	554.13	10,560	280	10,840	105
29-Apr-2010	11:00	683.32	553.92	10,560	280	10,840	105
29-Apr-2010	12:00	683.32	553.72	10,500	280	10,780	105
29-Apr-2010	13:00	683.31	555.11	14,200	280	14,480	140
29-Apr-2010	14:00	683.31	556.21	14,280	280	14,560	140
29-Apr-2010	15:00	683.31	556.41	14,280	280	14,560	140
29-Apr-2010	16:00	683.31	556.61	14,280	280	14,560	140
29-Apr-2010	17:00	683.31	556.81	14,280	280	14,560	140
29-Apr-2010	18:00	683.31	556.81	14,280	280	14,560	140
29-Apr-2010	19:00	683.31	556.81	14,280	280	14,560	140
29-Apr-2010	20:00	683.31	556.81	14,280	280	14,560	140
29-Apr-2010	21:00	683.31	556.81	14,280	280	14,560	140
29-Apr-2010	22:00	683.31	556.81	14,280	280	14,560	140
29-Apr-2010	23:00	683.31	556.81	14,280	280	14,560	140
29-Apr-2010	24:00:00	683.31	556.81	14,280	280	14,560	140
30-Apr-2010	1:00	683.29	556.89	14,280	280	14,560	140
30-Apr-2010	2:00	683.27	556.87	14,280	280	14,560	140
30-Apr-2010	3:00	683.26	556.86	14,280	280	14,560	140

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Wolf Creek Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Tailwater Elevation ft	Wolf Creek Dam Turbine Discharge cfs	Wolf Creek Dam Gate Release cfs	Wolf Creek Dam Total Discharge cfs	Wolf Creek Dam Gross Energy mwh
30-Apr-2010	4:00	683.25	556.85	14,280	280	14,560	140
30-Apr-2010	5:00	683.25	556.85	14,280	280	14,560	140
30-Apr-2010	6:00	683.25	556.84	14,280	280	14,560	140
30-Apr-2010	7:00	683.23	556.93	14,400	280	14,680	140
30-Apr-2010	8:00	683.22	556.92	14,400	280	14,680	140
30-Apr-2010	9:00	683.21	556.91	14,400	280	14,680	140
30-Apr-2010	10:00	683.19	557.09	14,400	280	14,680	140
30-Apr-2010	11:00	683.17	557.07	14,400	280	14,680	140
30-Apr-2010	12:00	683.15	557.05	14,400	280	14,680	140
30-Apr-2010	13:00	683.13	557.03	14,400	280	14,680	140
30-Apr-2010	14:00	683.12	557.02	14,400	280	14,680	140
30-Apr-2010	15:00	683.11	557.01	14,400	280	14,680	140
30-Apr-2010	16:00	683.10	557.00	14,400	280	14,680	140
30-Apr-2010	17:00	683.08	557.08	14,400	280	14,680	140
30-Apr-2010	18:00	683.06	557.06	14,400	280	14,680	140
30-Apr-2010	19:00	683.06	557.06	14,400	280	14,680	140
30-Apr-2010	20:00	683.05	557.05	14,400	280	14,680	140
30-Apr-2010	21:00	683.03	557.03	14,400	280	14,680	140
30-Apr-2010	22:00	683.01	557.01	14,400	280	14,680	140
30-Apr-2010	23:00	683.01	557.01	14,400	280	14,680	140
30-Apr-2010	24:00:00	682.99	557.09	14,400	280	14,680	140
1-May-2010	1:00	682.99	557.09	14,400	280	14,680	140
1-May-2010	2:00	682.99	557.09	14,400	280	14,680	140
1-May-2010	3:00	682.99	557.09	14,400	280	14,680	140
1-May-2010	4:00	682.98	557.08	14,400	280	14,680	140
1-May-2010	5:00	682.96	557.06	14,400	280	14,680	140
1-May-2010	6:00	682.94	557.04	14,400	280	14,680	140

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Wolf Creek Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Tailwater Elevation ft	Wolf Creek Dam Turbine Discharge cfs	Wolf Creek Dam Gate Release cfs	Wolf Creek Dam Total Discharge cfs	Wolf Creek Dam Gross Energy mwh
1-May-2010	7:00	682.92	557.02	14,400	280	14,680	140
1-May-2010	8:00	682.88	557.08	14,400	280	14,680	140
1-May-2010	9:00	682.92	557.02	14,400	280	14,680	140
1-May-2010	10:00	682.92	557.12	14,400	280	14,680	140
1-May-2010	11:00	682.88	557.08	14,400	280	14,680	140
1-May-2010	12:00	682.88	557.08	14,400	280	14,680	140
1-May-2010	13:00	682.98	557.08	14,400	280	14,680	140
1-May-2010	14:00	682.98	557.08	14,400	280	14,680	140
1-May-2010	15:00	682.89	557.09	14,400	280	14,680	140
1-May-2010	16:00	682.89	557.19	14,400	280	14,680	140
1-May-2010	17:00	683.01	557.31	14,400	280	14,680	140
1-May-2010	18:00	683.06	557.56	14,400	280	14,680	140
1-May-2010	19:00	683.15	557.55	14,400	280	14,680	140
1-May-2010	20:00	683.15	557.55	14,400	280	14,680	140
1-May-2010	21:00	683.20	557.50	14,400	280	14,680	140
1-May-2010	22:00	683.20	557.50	14,400	280	14,680	140
1-May-2010	23:00	683.30	557.50	14,400	280	14,680	140
1-May-2010	24:00:00	683.35	557.55	14,400	280	14,680	140
2-May-2010	1:00	683.61	557.81	14,400	280	14,680	140
2-May-2010	2:00	683.82	557.92	14,400	280	14,680	140
2-May-2010	3:00	684.04	558.24	14,400	280	14,680	140
2-May-2010	4:00	684.21	558.31	14,400	280	14,680	140
2-May-2010	5:00	684.36	558.36	14,400	280	14,680	140
2-May-2010	6:00	684.50	558.30	14,400	280	14,680	140
2-May-2010	7:00	684.55	558.25	14,400	280	14,680	140
2-May-2010	8:00	684.70	558.10	14,280	280	14,560	140
2-May-2010	9:00	684.76	558.06	14,280	280	14,560	140

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Wolf Creek Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Tailwater Elevation ft	Wolf Creek Dam Turbine Discharge cfs	Wolf Creek Dam Gate Release cfs	Wolf Creek Dam Total Discharge cfs	Wolf Creek Dam Gross Energy mwh
2-May-2010	10:00	684.94	558.04	14,280	280	14,560	140
2-May-2010	11:00	685.02	558.02	14,280	280	14,560	140
2-May-2010	12:00	685.15	558.05	14,280	280	14,560	140
2-May-2010	13:00	685.33	558.23	14,280	280	14,560	140
2-May-2010	14:00	685.50	558.40	14,280	280	14,560	140
2-May-2010	15:00	685.72	558.52	14,280	280	14,560	140
2-May-2010	16:00	685.90	558.90	14,280	280	14,560	140
2-May-2010	17:00	686.24	559.64	14,280	280	14,560	140
2-May-2010	18:00	686.75	559.95	14,280	280	14,560	140
2-May-2010	19:00	687.25	562.35	14,520	280	14,800	140
2-May-2010	20:00	687.62	563.12	14,520	280	14,800	140
2-May-2010	21:00	688.13	563.73	14,600	280	14,880	140
2-May-2010	22:00	688.60	564.20	14,600	280	14,880	140
2-May-2010	23:00	689.11	564.51	14,520	280	14,800	140
2-May-2010	24:00:00	689.54	563.24	7,200	280	7,480	70
3-May-2010	1:00	689.93	562.13	0	280	280	0
3-May-2010	2:00	690.40	561.50	0	280	280	0
3-May-2010	3:00	690.83	561.03	0	280	280	0
3-May-2010	4:00	691.25	560.45	0	280	280	0
3-May-2010	5:00	691.72	559.82	0	280	280	0
3-May-2010	6:00	692.14	558.84	0	280	280	0
3-May-2010	7:00	692.63	557.73	0	280	280	0
3-May-2010	8:00	693.00	556.50	0	280	280	0
3-May-2010	9:00	693.36	556.06	0	280	280	0
3-May-2010	10:00	693.82	555.02	0	280	280	0
3-May-2010	11:00	694.20	554.00	0	280	280	0
3-May-2010	12:00	694.54	553.54	0	280	280	0

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Wolf Creek Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Tailwater Elevation ft	Wolf Creek Dam Turbine Discharge cfs	Wolf Creek Dam Gate Release cfs	Wolf Creek Dam Total Discharge cfs	Wolf Creek Dam Gross Energy mwh
3-May-2010	13:00	694.88	552.28	0	280	280	0
3-May-2010	14:00	695.30	551.20	0	280	280	0
3-May-2010	15:00	695.66	550.36	0	280	280	0
3-May-2010	16:00	695.85	549.85	0	280	280	0
3-May-2010	17:00	696.18	548.98	0	280	280	0
3-May-2010	18:00	696.40	548.40	0	280	280	0
3-May-2010	19:00	696.78	547.68	0	280	280	0
3-May-2010	20:00	697.15	546.75	0	280	280	0
3-May-2010	21:00	697.46	546.26	0	280	280	0
3-May-2010	22:00	697.78	545.48	0	280	280	0
3-May-2010	23:00	698.02	545.02	0	280	280	0
3-May-2010	24:00:00	698.37	544.57	0	280	280	0
4-May-2010	1:00	698.54	549.54	6,900	280	7,180	80
4-May-2010	2:00	698.76	550.46	6,960	280	7,240	80
4-May-2010	3:00	698.98	550.98	6,960	280	7,240	80
4-May-2010	4:00	699.22	551.22	6,960	280	7,240	80
4-May-2010	5:00	699.44	551.34	6,960	280	7,240	80
4-May-2010	6:00	699.64	551.34	6,960	280	7,240	80
4-May-2010	7:00	699.87	551.47	6,960	280	7,240	80
4-May-2010	8:00	700.10	551.50	6,900	280	7,180	80
4-May-2010	9:00	700.16	551.56	6,900	280	7,180	80
4-May-2010	10:00	700.29	551.59	6,900	280	7,180	80
4-May-2010	11:00	700.48	551.58	6,900	280	7,180	80
4-May-2010	12:00	700.67	551.57	6,900	280	7,180	80
4-May-2010	13:00	700.79	553.09	10,440	280	10,720	120
4-May-2010	14:00	700.95	553.65	10,500	280	10,780	120
4-May-2010	15:00	701.12	553.72	10,500	280	10,780	120

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Wolf Creek Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Tailwater Elevation ft	Wolf Creek Dam Turbine Discharge cfs	Wolf Creek Dam Gate Release cfs	Wolf Creek Dam Total Discharge cfs	Wolf Creek Dam Gross Energy mwh
4-May-2010	16:00	701.24	553.74	10,500	280	10,780	120
4-May-2010	17:00	701.36	553.76	10,440	280	10,720	120
4-May-2010	18:00	701.47	553.87	10,440	280	10,720	120
4-May-2010	19:00	701.59	553.99	10,440	280	10,720	120
4-May-2010	20:00	701.71	554.01	10,440	280	10,720	120
4-May-2010	21:00	701.82	554.02	10,440	280	10,720	120
4-May-2010	22:00	701.93	554.03	10,440	280	10,720	120
4-May-2010	23:00	702.04	554.14	10,440	280	10,720	120
4-May-2010	24:00:00	702.15	554.15	10,440	280	10,720	120
5-May-2010	1:00	702.22	554.12	10,440	280	10,720	120
5-May-2010	2:00	702.30	554.10	10,440	280	10,720	120
5-May-2010	3:00	702.38	554.18	10,440	280	10,720	120
5-May-2010	4:00	702.46	554.16	10,440	280	10,720	120
5-May-2010	5:00	702.53	554.13	10,440	280	10,720	120
5-May-2010	6:00	702.60	554.10	10,440	280	10,720	120
5-May-2010	7:00	702.65	554.35	10,440	280	10,720	120
5-May-2010	8:00	702.72	554.42	10,440	280	10,720	120
5-May-2010	9:00	702.78	554.38	10,440	280	10,720	120
5-May-2010	10:00	702.84	554.44	10,440	280	10,720	120
5-May-2010	11:00	702.90	554.40	10,440	280	10,720	120
5-May-2010	12:00	702.96	554.46	10,350	280	10,630	120
5-May-2010	13:00	702.98	556.48	17,500	280	17,780	200
5-May-2010	14:00	703.02	558.42	20,450	280	20,730	225
5-May-2010	15:00	703.08	559.08	20,650	280	20,930	225
5-May-2010	16:00	703.14	559.44	20,650	280	20,930	225
5-May-2010	17:00	703.16	559.56	20,650	280	20,930	225
5-May-2010	18:00	703.20	559.70	20,650	280	20,930	225

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Wolf Creek Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Tailwater Elevation ft	Wolf Creek Dam Turbine Discharge cfs	Wolf Creek Dam Gate Release cfs	Wolf Creek Dam Total Discharge cfs	Wolf Creek Dam Gross Energy mwh
5-May-2010	19:00	703.23	559.93	20,900	280	21,180	225
5-May-2010	20:00	703.25	560.05	20,900	280	21,180	225
5-May-2010	21:00	703.28	560.18	20,900	280	21,180	225
5-May-2010	22:00	703.31	560.21	20,900	280	21,180	225
5-May-2010	23:00	703.34	560.24	20,900	280	21,180	225
5-May-2010	24:00:00	703.37	560.27	20,900	280	21,180	225
6-May-2010	1:00	703.40	560.30	20,900	280	21,180	225
6-May-2010	2:00	703.43	560.43	20,900	280	21,180	225
6-May-2010	3:00	703.46	560.46	20,900	280	21,180	225
6-May-2010	4:00	703.49	560.59	20,900	280	21,180	225
6-May-2010	5:00	703.51	560.61	20,900	280	21,180	225
6-May-2010	6:00	703.54	560.64	20,900	280	21,180	225
6-May-2010	7:00	703.56	560.66	20,900	280	21,180	225
6-May-2010	8:00	703.58	560.68	20,900	280	21,180	225
6-May-2010	9:00	703.62	560.62	20,900	280	21,180	225
6-May-2010	10:00	703.66	560.66	20,900	280	21,180	225
6-May-2010	11:00	703.66	561.46	21,000	3,300	24,300	225
6-May-2010	12:00	703.66	561.86	21,000	3,300	24,300	225
6-May-2010	13:00	703.66	561.96	21,000	3,300	24,300	225
6-May-2010	14:00	703.66	562.06	21,000	3,300	24,300	225
6-May-2010	15:00	703.70	562.10	21,000	3,300	24,300	225
6-May-2010	16:00	703.70	562.10	21,000	3,300	24,300	225
6-May-2010	17:00	703.70	562.10	21,000	3,300	24,300	225
6-May-2010	18:00	703.70	562.10	21,000	3,300	24,300	225
6-May-2010	19:00	703.73	562.23	21,000	3,300	24,300	225
6-May-2010	20:00	703.76	562.26	21,000	3,300	24,300	225
6-May-2010	21:00	703.79	562.29	21,000	3,300	24,300	225

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Wolf Creek Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Wolf Creek Dam Headwater Elevation ft	Wolf Creek Dam Tailwater Elevation ft	Wolf Creek Dam Turbine Discharge cfs	Wolf Creek Dam Gate Release cfs	Wolf Creek Dam Total Discharge cfs	Wolf Creek Dam Gross Energy mwh
6-May-2010	22:00	703.81	562.31	21,000	3,300	24,300	225
6-May-2010	23:00	703.83	562.33	21,000	3,300	24,300	225
6-May-2010	24:00:00	703.86	562.36	21,000	3,300	24,300	225
7-May-2010	1:00	703.84	562.34	22,150	3,300	25,450	225
7-May-2010	2:00	703.82	562.42	22,150	3,300	25,450	225
7-May-2010	3:00	703.79	562.49	22,150	3,300	25,450	225
7-May-2010	4:00	703.76	562.56	22,150	3,300	25,450	225
7-May-2010	5:00	703.76	562.56	22,150	3,300	25,450	225
7-May-2010	6:00	703.75	562.55	22,150	3,300	25,450	225

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Cordell Hull Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Turbine Discharge cfs	Cordell Hull Dam Gate Release cfs	Cordell Hull Dam Total Discharge cfs	Cordell Hull Dam Gross Energy mwh
29-Apr-2010	1:00	504.90	450.90	15,800	0	15,800	66
29-Apr-2010	2:00	504.90	450.90	15,800	0	15,800	66
29-Apr-2010	3:00	504.90	450.90	15,800	0	15,800	66
29-Apr-2010	4:00	504.90	450.90	15,800	0	15,800	66
29-Apr-2010	5:00	504.90	450.90	15,800	0	15,800	66
29-Apr-2010	6:00	504.90	450.90	15,800	0	15,800	66
29-Apr-2010	7:00	504.88	450.88	15,800	0	15,800	66
29-Apr-2010	8:00	504.89	450.89	15,800	0	15,800	66
29-Apr-2010	9:00	504.89	450.89	15,800	0	15,800	66
29-Apr-2010	10:00	504.89	450.79	15,800	0	15,800	66
29-Apr-2010	11:00	504.89	450.79	15,800	0	15,800	66
29-Apr-2010	12:00	504.89	450.69	15,800	0	15,800	66
29-Apr-2010	13:00	504.90	450.80	15,800	0	15,800	66
29-Apr-2010	14:00	504.90	450.80	15,800	0	15,800	66
29-Apr-2010	15:00	504.92	450.92	15,800	0	15,800	66
29-Apr-2010	16:00	504.92	451.02	15,800	0	15,800	66
29-Apr-2010	17:00	504.92	451.02	15,800	0	15,800	66
29-Apr-2010	18:00	504.92	451.02	15,800	0	15,800	66
29-Apr-2010	19:00	504.85	452.65	24,800	0	24,800	99
29-Apr-2010	20:00	504.75	453.35	25,400	0	25,400	99
29-Apr-2010	21:00	504.75	453.55	25,400	0	25,400	99
29-Apr-2010	22:00	504.80	451.90	16,200	0	16,200	66
29-Apr-2010	23:00	504.80	451.40	16,200	0	16,200	66
29-Apr-2010	24:00:00	504.80	451.30	16,200	0	16,200	66
30-Apr-2010	1:00	504.80	451.20	15,800	0	15,800	66
30-Apr-2010	2:00	504.80	451.10	15,800	0	15,800	66
30-Apr-2010	3:00	504.80	451.00	15,800	0	15,800	66

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Cordell Hull Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Turbine Discharge cfs	Cordell Hull Dam Gate Release cfs	Cordell Hull Dam Total Discharge cfs	Cordell Hull Dam Gross Energy mwh
30-Apr-2010	4:00	504.80	451.00	15,800	0	15,800	66
30-Apr-2010	5:00	504.82	450.92	15,800	0	15,800	66
30-Apr-2010	6:00	504.82	450.92	15,800	0	15,800	66
30-Apr-2010	7:00	504.82	450.82	15,800	0	15,800	66
30-Apr-2010	8:00	504.84	450.64	15,800	0	15,800	66
30-Apr-2010	9:00	504.84	450.54	15,800	0	15,800	66
30-Apr-2010	10:00	504.85	450.45	15,800	0	15,800	66
30-Apr-2010	11:00	504.85	450.38	15,700	0	15,700	66
30-Apr-2010	12:00	504.86	450.26	15,700	0	15,700	66
30-Apr-2010	13:00	504.86	450.16	15,600	0	15,600	66
30-Apr-2010	14:00	504.68	452.48	24,700	0	24,700	99
30-Apr-2010	15:00	504.69	452.79	24,700	0	24,700	99
30-Apr-2010	16:00	504.64	453.04	24,700	0	24,700	99
30-Apr-2010	17:00	504.57	453.37	25,300	0	25,300	99
30-Apr-2010	18:00	504.54	453.44	25,300	0	25,300	99
30-Apr-2010	19:00	504.50	453.60	25,300	0	25,300	99
30-Apr-2010	20:00	504.45	453.95	25,300	0	25,300	99
30-Apr-2010	21:00	504.35	454.25	25,900	0	25,900	99
30-Apr-2010	22:00	504.45	452.65	16,500	0	16,500	66
30-Apr-2010	23:00	504.45	452.35	16,500	0	16,500	66
30-Apr-2010	24:00:00	504.45	452.15	16,500	0	16,500	66
1-May-2010	1:00	504.50	451.80	16,200	0	16,200	66
1-May-2010	2:00	504.50	451.60	16,200	0	16,200	66
1-May-2010	3:00	504.45	451.45	16,200	0	16,200	66
1-May-2010	4:00	504.45	451.45	16,200	0	16,200	66
1-May-2010	5:00	504.50	451.30	16,200	0	16,200	66
1-May-2010	6:00	504.55	451.35	16,200	0	16,200	66

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Cordell Hull Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Turbine Discharge cfs	Cordell Hull Dam Gate Release cfs	Cordell Hull Dam Total Discharge cfs	Cordell Hull Dam Gross Energy mwh
1-May-2010	7:00	504.50	451.40	16,200	0	16,200	66
1-May-2010	8:00	504.50	451.30	16,200	0	16,200	66
1-May-2010	9:00	504.54	451.34	16,200	0	16,200	66
1-May-2010	10:00	504.66	451.16	15,800	0	15,800	66
1-May-2010	11:00	504.42	453.02	25,400	0	25,400	99
1-May-2010	12:00	504.45	453.45	25,400	0	25,400	99
1-May-2010	13:00	504.47	453.77	25,400	0	25,400	99
1-May-2010	14:00	504.43	453.93	25,400	0	25,400	99
1-May-2010	15:00	504.50	454.30	26,000	0	26,000	99
1-May-2010	16:00	504.48	456.08	30,600	0	30,600	111
1-May-2010	17:00	504.70	457.50	32,400	0	32,400	114
1-May-2010	18:00	504.80	460.10	34,100	2,800	36,900	114
1-May-2010	19:00	504.89	462.79	37,100	5,600	42,700	114
1-May-2010	20:00	504.84	464.94	37,000	11,300	48,300	109
1-May-2010	21:00	504.97	466.37	37,000	11,300	48,300	105
1-May-2010	22:00	505.10	467.20	38,400	11,300	49,700	105
1-May-2010	23:00	505.25	467.95	35,700	11,400	47,100	99
1-May-2010	24:00:00	505.32	469.12	38,700	14,300	53,000	99
2-May-2010	1:00	505.25	470.45	38,300	23,300	61,600	95
2-May-2010	2:00	505.30	471.00	38,300	23,300	61,600	95
2-May-2010	3:00	505.35	471.35	37,600	23,300	60,900	91
2-May-2010	4:00	505.40	471.60	35,500	23,300	58,800	86
2-May-2010	5:00	505.42	471.82	34,500	23,300	57,800	84
2-May-2010	6:00	505.47	471.87	34,500	23,300	57,800	84
2-May-2010	7:00	505.47	472.07	36,000	23,400	59,400	84
2-May-2010	8:00	505.48	472.18	36,000	23,400	59,400	84
2-May-2010	9:00	505.47	472.17	36,000	23,400	59,400	84

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Cordell Hull Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Turbine Discharge cfs	Cordell Hull Dam Gate Release cfs	Cordell Hull Dam Total Discharge cfs	Cordell Hull Dam Gross Energy mwh
2-May-2010	10:00	505.47	472.17	36,000	23,400	59,400	84
2-May-2010	11:00	505.42	472.22	35,500	23,300	58,800	83
2-May-2010	12:00	505.40	472.20	36,000	23,300	59,300	84
2-May-2010	13:00	505.36	472.16	35,500	23,300	58,800	83
2-May-2010	14:00	505.35	472.05	35,500	23,300	58,800	83
2-May-2010	15:00	505.42	472.22	35,500	23,300	58,800	83
2-May-2010	16:00	505.56	472.56	36,000	23,400	59,400	84
2-May-2010	17:00	505.87	473.27	35,000	23,500	58,500	82
2-May-2010	18:00	506.16	474.06	35,000	23,500	58,500	79
2-May-2010	19:00	506.50	474.80	37,000	23,600	60,600	83
2-May-2010	20:00	506.83	475.83	35,500	30,000	65,500	77
2-May-2010	21:00	507.17	476.47	35,500	30,100	65,600	77
2-May-2010	22:00	507.46	477.26	31,300	35,200	66,500	66
2-May-2010	23:00	507.80	478.10	32,900	41,600	74,500	69
2-May-2010	24:00:00	507.98	479.08	30,800	51,500	82,300	65
3-May-2010	1:00	508.25	480.35	34,000	60,000	94,000	65
3-May-2010	2:00	508.30	481.40	31,600	72,300	103,900	59
3-May-2010	3:00	508.21	482.81	28,600	84,500	113,100	52
3-May-2010	4:00	508.27	483.37	24,200	91,300	115,500	46
3-May-2010	5:00	508.33	483.83	25,300	93,700	119,000	44
3-May-2010	6:00	508.02	485.12	24,800	105,000	129,800	37
3-May-2010	7:00	508.05	485.35	24,900	105,200	130,100	41
3-May-2010	8:00	507.97	485.77	21,500	105,000	126,500	31
3-May-2010	9:00	507.91	486.01	20,500	104,900	125,400	28
3-May-2010	10:00	507.87	486.37	20,500	104,900	125,400	28
3-May-2010	11:00	507.80	486.50	20,200	104,700	124,900	26
3-May-2010	12:00	507.86	486.36	20,000	99,500	119,500	25

DRAFT

Cordell Hull Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Turbine Discharge cfs	Cordell Hull Dam Gate Release cfs	Cordell Hull Dam Total Discharge cfs	Cordell Hull Dam Gross Energy mwh
3-May-2010	13:00	507.90	486.10	19,100	94,300	113,400	24
3-May-2010	14:00	507.88	486.18	19,600	94,300	113,900	26
3-May-2010	15:00	507.92	486.02	19,100	90,900	110,000	24
3-May-2010	16:00	507.86	485.96	19,900	90,900	110,800	25
3-May-2010	17:00	507.88	485.78	19,500	87,500	107,000	26
3-May-2010	18:00	507.95	485.45	19,500	80,700	100,200	26
3-May-2010	19:00	507.93	485.13	20,100	80,700	100,800	29
3-May-2010	20:00	507.92	484.82	20,900	77,300	98,200	30
3-May-2010	21:00	507.93	484.33	21,600	73,700	95,300	32
3-May-2010	22:00	507.91	484.01	22,400	70,200	92,600	34
3-May-2010	23:00	507.90	483.50	22,800	66,900	89,700	35
3-May-2010	24:00:00	507.90	483.30	22,600	63,500	86,100	37
4-May-2010	1:00	507.89	482.59	23,500	60,000	83,500	38
4-May-2010	2:00	507.88	481.88	23,400	55,000	78,400	42
4-May-2010	3:00	507.88	481.38	24,300	50,000	74,300	44
4-May-2010	4:00	507.93	480.53	25,500	45,100	70,600	48
4-May-2010	5:00	507.88	479.98	26,900	43,500	70,400	53
4-May-2010	6:00	507.86	479.56	24,400	64,600	89,000	48
4-May-2010	7:00	507.75	479.05	25,000	40,200	65,200	51
4-May-2010	8:00	507.62	478.62	27,300	40,100	67,400	56
4-May-2010	9:00	507.49	478.39	25,600	40,000	65,600	52
4-May-2010	10:00	507.31	477.91	30,200	39,900	70,100	61
4-May-2010	11:00	507.12	477.62	29,100	39,800	68,900	59
4-May-2010	12:00	506.92	477.32	28,200	39,800	68,000	60
4-May-2010	13:00	506.72	477.12	26,800	39,600	66,400	57
4-May-2010	14:00	506.47	476.77	30,400	39,500	69,900	64
4-May-2010	15:00	506.24	476.44	26,800	39,400	66,200	57

DRAFT

Cordell Hull Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Turbine Discharge cfs	Cordell Hull Dam Gate Release cfs	Cordell Hull Dam Total Discharge cfs	Cordell Hull Dam Gross Energy mwh
4-May-2010	16:00	505.98	476.18	27,800	39,300	67,100	59
4-May-2010	17:00	505.90	475.50	27,800	36,900	64,700	59
4-May-2010	18:00	505.68	474.98	27,100	29,700	56,800	60
4-May-2010	19:00	505.52	474.02	28,400	23,400	51,800	64
4-May-2010	20:00	505.32	473.62	30,100	23,300	53,400	69
4-May-2010	21:00	505.18	472.78	31,600	20,200	51,800	72
4-May-2010	22:00	505.03	472.33	29,400	17,100	46,500	70
4-May-2010	23:00	504.95	471.45	31,100	11,400	42,500	75
4-May-2010	24:00:00	504.92	470.22	29,800	5,700	35,500	76
5-May-2010	1:00	504.74	469.64	33,200	5,600	38,800	84
5-May-2010	2:00	504.54	468.84	32,800	5,600	38,400	86
5-May-2010	3:00	504.50	468.10	28,800	5,600	34,400	76
5-May-2010	4:00	504.39	467.49	24,100	5,600	29,700	66
5-May-2010	5:00	504.30	466.70	25,900	5,600	31,500	73
5-May-2010	6:00	504.19	466.29	23,000	5,600	28,600	69
5-May-2010	7:00	504.03	465.73	30,400	0	30,400	85
5-May-2010	8:00	503.86	465.36	31,800	0	31,800	90
5-May-2010	9:00	503.73	464.93	33,000	0	33,000	95
5-May-2010	10:00	503.58	464.58	33,400	0	33,400	96
5-May-2010	11:00	503.26	464.06	10,800	35,500	46,300	31
5-May-2010	12:00	503.28	484.38	10,400	35,500	45,900	30
5-May-2010	13:00	502.90	464.50	8,900	35,500	44,400	25
5-May-2010	14:00	503.50	461.30	10,200	11,800	22,000	32
5-May-2010	15:00	503.50	459.60	10,000	0	10,000	33
5-May-2010	16:00	503.40	458.50	9,700	0	9,700	33
5-May-2010	17:00	503.42	457.32	10,100	0	10,100	35
5-May-2010	18:00	503.51	457.41	9,500	0	9,500	33

DRAFT

Cordell Hull Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cordell Hull Dam Headwater Elevation ft	Cordell Hull Dam Tailwater Elevation ft	Cordell Hull Dam Turbine Discharge cfs	Cordell Hull Dam Gate Release cfs	Cordell Hull Dam Total Discharge cfs	Cordell Hull Dam Gross Energy mwh
5-May-2010	19:00	503.60	455.80	9,100	0	9,100	33
5-May-2010	20:00	503.65	455.25	9,100	0	9,100	33
5-May-2010	21:00	503.70	454.90	8,900	0	8,900	33
5-May-2010	22:00	503.77	454.37	8,900	0	8,900	33
5-May-2010	23:00	503.85	454.15	8,700	0	8,700	33
5-May-2010	24:00:00	503.90	453.90	8,700	0	8,700	33
6-May-2010	1:00	503.95	453.65	8,700	0	8,700	33
6-May-2010	2:00	504.03	453.53	8,500	0	8,500	33
6-May-2010	3:00	503.90	455.00	17,700	0	17,700	66
6-May-2010	4:00	503.97	455.37	17,700	0	17,700	66
6-May-2010	5:00	504.02	455.52	17,700	0	17,700	66
6-May-2010	6:00	503.93	455.63	18,200	0	18,200	66
6-May-2010	7:00	503.90	455.70	18,200	0	18,200	66
6-May-2010	8:00	504.01	455.71	18,200	0	18,200	66
6-May-2010	9:00	504.03	455.83	18,200	0	18,200	66
6-May-2010	10:00	504.03	455.83	18,200	0	18,200	66
6-May-2010	11:00	504.05	455.85	18,200	0	18,200	66
6-May-2010	12:00	504.06	455.96	18,200	0	18,200	66
6-May-2010	13:00	503.81	458.01	28,500	0	28,500	99
6-May-2010	14:00	503.85	458.55	29,300	0	29,300	99
6-May-2010	15:00	503.80	459.00	29,300	0	29,300	99
6-May-2010	16:00	503.73	459.33	30,000	0	30,000	99
6-May-2010	17:00	503.90	457.60	19,000	0	19,000	66
6-May-2010	18:00	503.95	457.25	18,600	0	18,600	66
6-May-2010	19:00	503.88	456.98	18,600	0	18,600	66
6-May-2010	20:00	503.96	456.76	18,600	0	18,600	66
6-May-2010	21:00	504.05	456.55	18,200	0	18,200	66

DRAFT

Cordell Hull Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	**Time**	**Cordell Hull Dam Headwater Elevation ft**	**Cordell Hull Dam Tailwater Elevation ft**	**Cordell Hull Dam Turbine Discharge cfs**	**Cordell Hull Dam Gate Release cfs**	**Cordell Hull Dam Total Discharge cfs**	**Cordell Hull Dam Gross Energy mwh**
6-May-2010	22:00	504.08	456.38	18,200	0	18,200	66
6-May-2010	23:00	504.11	456.41	18,200	0	18,200	66
6-May-2010	24:00:00	504.18	456.28	18,200	0	18,200	66
7-May-2010	1:00	504.02	458.22	28,500	0	28,500	99
7-May-2010	2:00	503.99	458.79	29,300	0	29,300	99
7-May-2010	3:00	503.99	459.19	29,300	0	29,300	99
7-May-2010	4:00	503.94	459.64	30,000	0	30,000	99
7-May-2010	5:00	503.88	459.78	30,000	0	30,000	99
7-May-2010	6:00	503.84	460.04	30,000	0	30,000	99
7-May-2010	7:00	503.78	460.28	30,000	0	30,000	99
7-May-2010	8:00	503.74	460.44	30,800	0	30,800	99

DRAFT

Old Hickory Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Turbine Discharge cfs	Old Hickory Dam Gate Release cfs	Old Hickory Dam Total Discharge cfs	Old Hickory Dam Gross Energy mwh
29-Apr-2010	1:00	445.07	393.27	19,200	0	19,200	75
29-Apr-2010	2:00	445.07	393.37	19,200	0	19,200	75
29-Apr-2010	3:00	445.07	393.37	19,200	0	19,200	75
29-Apr-2010	4:00	445.07	393.27	19,200	0	19,200	75
29-Apr-2010	5:00	445.08	393.28	19,200	0	19,200	75
29-Apr-2010	6:00	445.05	393.35	19,200	0	19,200	75
29-Apr-2010	7:00	445.05	393.35	19,200	0	19,200	75
29-Apr-2010	8:00	445.00	393.20	19,200	0	19,200	75
29-Apr-2010	9:00	445.05	392.25	19,200	0	19,200	75
29-Apr-2010	10:00	445.00	393.20	19,200	0	19,200	75
29-Apr-2010	11:00	444.95	394.15	21,900	0	21,900	85
29-Apr-2010	12:00	444.95	394.45	23,400	0	23,400	90
29-Apr-2010	13:00	444.90	394.80	23,700	0	23,700	90
29-Apr-2010	14:00	444.90	395.00	23,700	0	23,700	90
29-Apr-2010	15:00	444.90	395.00	23,700	0	23,700	90
29-Apr-2010	16:00	444.90	395.00	23,700	0	23,700	90
29-Apr-2010	17:00	444.85	395.15	23,700	0	23,700	90
29-Apr-2010	18:00	444.85	395.15	23,700	0	23,700	90
29-Apr-2010	19:00	444.80	395.30	23,700	0	23,700	90
29-Apr-2010	20:00	444.77	395.47	24,000	0	24,000	90
29-Apr-2010	21:00	444.75	395.45	24,000	0	24,000	90
29-Apr-2010	22:00	444.72	395.52	24,000	0	24,000	90
29-Apr-2010	23:00	444.71	395.51	24,000	0	24,000	90
29-Apr-2010	24:00:00	444.68	395.58	24,000	0	24,000	90
30-Apr-2010	1:00	444.68	395.58	24,000	0	24,000	90
30-Apr-2010	2:00	444.69	395.69	24,000	0	24,000	90
30-Apr-2010	3:00	444.68	395.68	24,000	0	24,000	90

DRAFT

Old Hickory Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Turbine Discharge cfs	Old Hickory Dam Gate Release cfs	Old Hickory Dam Total Discharge cfs	Old Hickory Dam Gross Energy mwh
30-Apr-2010	4:00	444.68	395.78	24,000	0	24,000	90
30-Apr-2010	5:00	444.67	395.77	24,000	0	24,000	90
30-Apr-2010	6:00	444.64	395.74	24,000	0	24,000	90
30-Apr-2010	7:00	444.60	395.80	24,000	0	24,000	90
30-Apr-2010	8:00	444.60	395.80	24,000	0	24,000	90
30-Apr-2010	9:00	444.55	396.05	24,300	0	24,300	90
30-Apr-2010	10:00	444.55	395.05	22,500	0	22,500	85
30-Apr-2010	11:00	444.55	395.15	21,300	0	21,300	80
30-Apr-2010	12:00	444.50	394.70	19,800	0	19,800	75
30-Apr-2010	13:00	444.50	394.60	19,800	0	19,800	75
30-Apr-2010	14:00	444.45	394.85	20,100	0	20,100	75
30-Apr-2010	15:00	444.50	394.30	19,800	0	19,800	75
30-Apr-2010	16:00	444.50	394.60	19,800	0	19,800	75
30-Apr-2010	17:00	444.45	394.15	19,500	0	19,500	75
30-Apr-2010	18:00	444.45	394.15	19,500	0	19,500	75
30-Apr-2010	19:00	444.42	394.42	19,800	0	19,800	75
30-Apr-2010	20:00	444.50	393.90	19,800	0	19,800	75
30-Apr-2010	21:00	444.52	393.82	19,500	0	19,500	75
30-Apr-2010	22:00	444.54	393.74	19,500	0	19,500	75
30-Apr-2010	23:00	444.55	393.75	19,500	0	19,500	75
30-Apr-2010	24:00:00	444.55	393.95	19,500	0	19,500	75
1-May-2010	1:00	444.55	394.95	23,700	0	23,700	90
1-May-2010	2:00	444.56	394.76	23,700	0	23,700	90
1-May-2010	3:00	444.60	394.90	23,700	0	23,700	90
1-May-2010	4:00	444.59	395.09	24,000	0	24,000	90
1-May-2010	5:00	444.59	395.09	24,000	0	24,000	90
1-May-2010	6:00	444.55	395.15	24,000	0	24,000	90

DRAFT

Old Hickory Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Turbine Discharge cfs	Old Hickory Dam Gate Release cfs	Old Hickory Dam Total Discharge cfs	Old Hickory Dam Gross Energy mwh
1-May-2010	7:00	444.58	395.38	24,900	0	24,900	93
1-May-2010	8:00	444.64	396.14	25,200	0	25,200	94
1-May-2010	9:00	444.65	396.65	24,000	0	24,000	90
1-May-2010	10:00	444.68	396.48	24,000	0	24,000	88
1-May-2010	11:00	444.74	396.54	24,000	0	24,000	88
1-May-2010	12:00	444.82	396.82	24,300	0	24,300	89
1-May-2010	13:00	444.85	398.25	25,200	4,800	30,000	90
1-May-2010	14:00	444.83	399.93	24,900	9,500	34,400	87
1-May-2010	15:00	444.94	400.84	26,600	9,500	36,100	89
1-May-2010	16:00	445.05	402.55	26,400	15,300	41,700	85
1-May-2010	17:00	445.20	404.80	26,400	21,200	47,600	80
1-May-2010	18:00	445.30	406.70	29,100	25,900	55,000	84
1-May-2010	19:00	445.60	408.30	28,200	26,000	54,200	78
1-May-2010	20:00	445.80	409.50	29,400	31,000	60,400	78
1-May-2010	21:00	445.90	410.50	29,200	36,000	65,200	76
1-May-2010	22:00	446.21	411.61	29,300	41,000	70,300	74
1-May-2010	23:00	446.33	412.13	28,700	41,000	69,700	71
1-May-2010	24:00:00	446.45	413.05	28,500	46,000	74,500	69
2-May-2010	1:00	446.80	414.80	29,100	46,300	75,400	66
2-May-2010	2:00	446.97	414.87	27,600	46,300	73,900	63
2-May-2010	3:00	447.20	414.90	28,100	46,300	74,400	64
2-May-2010	4:00	447.37	414.97	28,100	46,300	74,400	64
2-May-2010	5:00	447.57	415.07	28,500	46,300	74,800	66
2-May-2010	6:00	447.75	415.05	27,000	46,300	73,300	63
2-May-2010	7:00	447.88	415.68	29,100	52,000	81,100	66
2-May-2010	8:00	448.12	416.48	28,200	52,000	80,200	63
2-May-2010	9:00	448.78	418.08	27,600	52,600	80,200	60

DRAFT

Old Hickory Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Turbine Discharge cfs	Old Hickory Dam Gate Release cfs	Old Hickory Dam Total Discharge cfs	Old Hickory Dam Gross Energy mwh
2-May-2010	10:00	449.40	419.60	27,700	52,600	80,300	59
2-May-2010	11:00	449.80	421.10	26,100	63,600	89,700	54
2-May-2010	12:00	450.38	423.48	23,900	83,100	107,000	49
2-May-2010	13:00	450.91	425.21	21,600	102,000	123,600	45
2-May-2010	14:00	451.45	426.65	21,300	109,000	130,300	42
2-May-2010	15:00	451.45	428.85	18,900	124,000	142,900	36
2-May-2010	16:00	451.35	430.35	13,200	150,000	163,200	21
2-May-2010	17:00	451.26	431.86	7,800	160,000	202,850	13
2-May-2010	18:00	451.10	433.10	0	222,400	212,260	0
2-May-2010	19:00	451.00	433.50	0	222,400	211,730	0
2-May-2010	20:00	450.90	434.00	0	222,400	211,400	0
2-May-2010	21:00	450.80	434.50	0	222,400	211,070	0
2-May-2010	22:00	450.75	434.65	0	217,400	204,960	0
2-May-2010	23:00	450.80	434.70	0	212,400	199,025	0
2-May-2010	24:00:00	450.80	434.60	0	207,400	193,400	0
3-May-2010	1:00	450.80	434.20	0	202,400	187,620	0
3-May-2010	2:00	451.15	433.55	0	197,400	181,840	0
3-May-2010	3:00	451.25	433.05	0	197,400	182,820	0
3-May-2010	4:00	451.20	432.90	0	202,400	183,100	0
3-May-2010	5:00	450.95	433.55	0	207,400	194,600	0
3-May-2010	6:00	450.95	433.65	0	207,400	193,850	0
3-May-2010	7:00	450.55	434.25	0	212,400	196,748	0
3-May-2010	8:00	450.40	434.50	0	212,400	198,405	0
3-May-2010	9:00	450.30	434.60	0	212,400	197,940	0
3-May-2010	10:00	450.20	434.80	0	212,400	197,630	0
3-May-2010	11:00	450.10	434.90	0	212,400	197,320	0
3-May-2010	12:00	449.95	435.05	0	212,400	197,010	0

DRAFT

Old Hickory Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Turbine Discharge cfs	Old Hickory Dam Gate Release cfs	Old Hickory Dam Total Discharge cfs	Old Hickory Dam Gross Energy mwh
3-May-2010	13:00	449.80	435.20	0	212,400	196,545	0
3-May-2010	14:00	449.70	434.90	0	207,400	190,400	0
3-May-2010	15:00	449.65	434.55	0	199,400	175,925	0
3-May-2010	16:00	449.80	434.00	0	195,000	165,402	0
3-May-2010	17:00	449.90	433.00	0	177,000	156,320	0
3-May-2010	18:00	450.00	432.60	0	167,000	150,183	0
3-May-2010	19:00	450.10	432.28	0	167,000	144,235	0
3-May-2010	20:00	450.20	431.70	0	167,000	144,450	0
3-May-2010	21:00	450.30	431.50	0	167,000	144,670	0
3-May-2010	22:00	450.40	431.20	0	167,000	144,885	0
3-May-2010	23:00	450.50	431.00	0	167,000	145,100	0
3-May-2010	24:00:00	450.55	430.85	0	167,000	145,210	0
4-May-2010	1:00	450.60	430.80	0	167,000	145,315	0
4-May-2010	2:00	450.65	430.65	0	167,000	145,425	0
4-May-2010	3:00	450.70	430.50	0	167,000	145,530	0
4-May-2010	4:00	450.70	430.40	0	167,000	145,530	0
4-May-2010	5:00	450.75	430.35	0	167,000	145,640	0
4-May-2010	6:00	450.80	430.40	0	167,000	145,750	0
4-May-2010	7:00	450.84	430.24	0	167,000	145,835	0
4-May-2010	8:00	450.86	430.26	0	167,000	145,880	0
4-May-2010	9:00	450.85	429.95	0	167,000	145,855	0
4-May-2010	10:00	450.85	430.05	0	167,000	145,855	0
4-May-2010	11:00	450.85	429.95	0	167,000	145,855	0
4-May-2010	12:00	450.85	429.95	0	167,000	145,855	0
4-May-2010	13:00	450.85	429.85	0	167,000	145,855	0
4-May-2010	14:00	450.85	429.85	0	167,000	145,855	0
4-May-2010	15:00	450.80	429.90	0	167,000	145,750	0

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Old Hickory Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Turbine Discharge cfs	Old Hickory Dam Gate Release cfs	Old Hickory Dam Total Discharge cfs	Old Hickory Dam Gross Energy mwh
4-May-2010	16:00	450.75	429.75	0	167,000	145,640	0
4-May-2010	17:00	450.75	429.75	0	167,000	145,640	0
4-May-2010	18:00	450.65	429.65	0	167,000	145,425	0
4-May-2010	19:00	450.58	429.78	0	167,000	145,275	0
4-May-2010	20:00	450.53	429.73	0	167,000	145,165	0
4-May-2010	21:00	450.48	429.58	0	167,000	145,055	0
4-May-2010	22:00	450.39	429.59	0	167,000	144,860	0
4-May-2010	23:00	450.30	429.50	0	167,000	144,670	0
4-May-2010	24:00:00	450.20	429.40	0	167,000	144,450	0
5-May-2010	1:00	450.12	429.52	0	167,000	144,280	0
5-May-2010	2:00	450.00	429.40	0	167,000	144,020	0
5-May-2010	3:00	449.90	429.30	0	167,000	143,805	0
5-May-2010	4:00	449.84	429.24	0	167,000	143,675	0
5-May-2010	5:00	449.70	429.20	0	167,000	143,370	0
5-May-2010	6:00	449.58	429.28	0	167,000	143,115	0
5-May-2010	7:00	449.40	429.10	0	167,000	142,720	0
5-May-2010	8:00	449.27	429.17	0	167,000	142,440	0
5-May-2010	9:00	449.09	429.09	0	162,000	142,045	0
5-May-2010	10:00	449.00	429.00	3,800	148,000	129,200	5
5-May-2010	11:00	448.65	429.25	15,600	125,000	134,405	27
5-May-2010	12:00	448.50	428.91	15,600	119,000	134,150	27
5-May-2010	13:00	448.30	428.60	15,600	118,000	121,550	27
5-May-2010	14:00	448.25	428.15	15,100	106,000	120,975	26
5-May-2010	15:00	448.05	427.85	15,600	105,600	108,965	27
5-May-2010	16:00	448.00	427.30	15,600	93,300	108,900	30
5-May-2010	17:00	448.05	426.45	18,000	81,000	99,000	33
5-May-2010	18:00	447.95	426.45	18,000	80,800	98,800	33

DRAFT

Old Hickory Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Turbine Discharge cfs	Old Hickory Dam Gate Release cfs	Old Hickory Dam Total Discharge cfs	Old Hickory Dam Gross Energy mwh
5-May-2010	19:00	447.84	426.44	18,000	76,000	94,000	33
5-May-2010	20:00	447.79	425.09	18,500	71,000	89,500	35
5-May-2010	21:00	447.70	424.60	18,200	71,000	89,200	35
5-May-2010	22:00	447.55	424.25	17,900	69,000	86,900	35
5-May-2010	23:00	447.40	423.60	19,200	64,000	83,200	37
5-May-2010	24:00:00	447.30	422.90	19,400	60,000	79,400	38
6-May-2010	1:00	447.20	422.40	20,800	55,000	75,800	41
6-May-2010	2:00	447.13	421.53	21,400	49,000	70,400	44
6-May-2010	3:00	447.00	421.10	21,400	49,000	70,400	44
6-May-2010	4:00	446.85	420.05	22,900	42,600	65,500	47
6-May-2010	5:00	446.73	419.33	23,400	38,100	61,500	48
6-May-2010	6:00	446.60	418.90	24,400	38,000	62,400	50
6-May-2010	7:00	446.45	418.05	25,100	38,000	63,100	52
6-May-2010	8:00	446.35	417.65	25,100	38,000	63,100	52
6-May-2010	9:00	446.23	417.33	25,800	38,000	63,800	54
6-May-2010	10:00	446.12	416.92	25,800	38,000	63,800	54
6-May-2010	11:00	445.99	416.49	25,900	38,000	63,900	55
6-May-2010	12:00	445.88	416.18	27,200	38,000	65,200	58
6-May-2010	13:00	445.77	415.37	28,200	33,000	61,200	60
6-May-2010	14:00	445.72	414.72	26,500	28,000	54,500	58
6-May-2010	15:00	445.63	414.23	27,700	28,000	55,700	62
6-May-2010	16:00	445.55	413.75	27,600	28,000	55,600	64
6-May-2010	17:00	445.50	413.40	28,100	28,000	56,100	64
6-May-2010	18:00	445.40	413.10	27,600	28,000	55,600	63
6-May-2010	19:00	445.29	412.69	28,500	28,000	56,500	66
6-May-2010	20:00	445.26	412.46	29,100	28,000	57,100	68
6-May-2010	21:00	445.17	412.07	29,100	28,000	57,100	68

DRAFT

Old Hickory Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Old Hickory Dam Headwater Elevation ft	Old Hickory Dam Tailwater Elevation ft	Old Hickory Dam Turbine Discharge cfs	Old Hickory Dam Gate Release cfs	Old Hickory Dam Total Discharge cfs	Old Hickory Dam Gross Energy mwh
6-May-2010	22:00	445.11	411.91	27,900	27,700	55,600	66
6-May-2010	23:00	445.06	411.76	28,500	27,700	56,200	69
6-May-2010	24:00:00	444.99	411.59	28,500	27,700	56,200	69
7-May-2010	1:00	444.91	411.41	27,300	27,600	54,900	66
7-May-2010	2:00	444.82	411.22	27,300	27,600	54,900	66
7-May-2010	3:00	444.76	411.06	28,500	27,600	56,100	69
7-May-2010	4:00	444.69	410.99	28,900	27,600	56,500	70
7-May-2010	5:00	444.64	410.44	28,700	23,400	52,100	71
7-May-2010	6:00	444.60	410.20	28,500	23,400	51,900	72

DRAFT

Cheatham Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Turbine Discharge cfs	Cheatham Dam Gate Release cfs	Cheatham Dam Total Discharge cfs	Cheatham Dam Gross Energy mwh
29-Apr-2010	1:00	384.98	362.98	14,800	0	14,800	24
29-Apr-2010	2:00	385.09	362.59	14,600	0	14,600	24
29-Apr-2010	3:00	385.20	362.10	14,400	0	14,400	24
29-Apr-2010	4:00	385.30	362.10	14,400	0	14,400	24
29-Apr-2010	5:00	385.41	361.91	14,200	0	14,200	24
29-Apr-2010	6:00	385.52	361.92	14,200	0	14,200	24
29-Apr-2010	7:00	385.65	361.85	14,000	0	14,000	24
29-Apr-2010	8:00	385.70	361.80	14,000	0	14,000	24
29-Apr-2010	9:00	385.55	362.75	21,600	0	21,600	36
29-Apr-2010	10:00	385.50	363.00	21,600	0	21,600	36
29-Apr-2010	11:00	385.50	363.20	21,600	0	21,600	36
29-Apr-2010	12:00	385.40	363.30	22,200	0	22,200	36
29-Apr-2010	13:00	385.40	363.40	22,200	0	22,200	36
29-Apr-2010	14:00	385.35	363.45	22,200	0	22,200	36
29-Apr-2010	15:00	385.30	363.40	22,200	0	22,200	36
29-Apr-2010	16:00	385.30	363.50	22,200	0	22,200	36
29-Apr-2010	17:00	385.30	363.60	22,200	0	22,200	36
29-Apr-2010	18:00	385.30	363.50	22,200	0	22,200	36
29-Apr-2010	19:00	385.35	363.45	22,200	0	22,200	36
29-Apr-2010	20:00	385.37	363.47	22,800	0	22,800	37
29-Apr-2010	21:00	385.40	363.50	22,800	0	22,800	37
29-Apr-2010	22:00	385.41	363.51	23,400	0	23,400	38
29-Apr-2010	23:00	385.46	363.56	22,800	0	22,800	37
29-Apr-2010	24:00:00	385.50	363.60	22,200	0	22,200	36
30-Apr-2010	1:00	385.54	363.64	22,800	0	22,800	37
30-Apr-2010	2:00	385.59	363.59	22,200	0	22,200	36
30-Apr-2010	3:00	385.62	363.52	22,800	0	22,800	37

DRAFT

Cheatham Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Turbine Discharge cfs	Cheatham Dam Gate Release cfs	Cheatham Dam Total Discharge cfs	Cheatham Dam Gross Energy mwh
30-Apr-2010	4:00	385.68	363.58	22,800	0	22,800	37
30-Apr-2010	5:00	385.73	363.53	22,200	0	22,200	36
30-Apr-2010	6:00	385.77	363.57	22,280	0	22,280	37
30-Apr-2010	7:00	385.80	363.60	22,280	0	22,280	37
30-Apr-2010	8:00	385.85	363.65	22,280	0	22,280	37
30-Apr-2010	9:00	385.90	363.60	22,900	0	22,900	38
30-Apr-2010	10:00	385.95	363.55	22,900	0	22,900	38
30-Apr-2010	11:00	386.00	363.50	22,400	0	22,400	37
30-Apr-2010	12:00	386.05	363.55	22,900	0	22,900	38
30-Apr-2010	13:00	385.80	364.30	23,000	5,600	28,600	36
30-Apr-2010	14:00	385.75	364.55	24,400	5,600	30,000	37
30-Apr-2010	15:00	385.60	364.90	23,500	5,600	29,100	34
30-Apr-2010	16:00	385.50	365.00	23,500	5,600	29,100	34
30-Apr-2010	17:00	385.40	365.00	23,500	5,600	29,100	34
30-Apr-2010	18:00	385.35	364.95	23,500	5,600	29,100	34
30-Apr-2010	19:00	385.13	365.13	22,400	5,500	27,900	32
30-Apr-2010	20:00	384.99	365.09	22,400	5,500	27,900	32
30-Apr-2010	21:00	384.88	365.08	23,600	5,500	29,100	33
30-Apr-2010	22:00	384.75	365.05	23,100	5,500	28,600	33
30-Apr-2010	23:00	384.62	365.12	22,000	5,500	27,500	31
30-Apr-2010	24:00:00	384.49	365.09	22,000	5,500	27,500	31
1-May-2010	1:00	384.36	365.06	23,200	5,500	28,700	32
1-May-2010	2:00	384.21	365.11	23,200	5,500	28,700	32
1-May-2010	3:00	384.07	365.07	21,200	5,500	26,700	29
1-May-2010	4:00	383.94	365.04	22,400	5,500	27,900	31
1-May-2010	5:00	383.79	365.09	22,400	5,500	27,900	31
1-May-2010	6:00	383.81	365.11	21,200	5,500	26,700	29

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Cheatham Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Turbine Discharge cfs	Cheatham Dam Gate Release cfs	Cheatham Dam Total Discharge cfs	Cheatham Dam Gross Energy mwh
1-May-2010	7:00	383.77	365.27	22,700	5,500	28,200	29
1-May-2010	8:00	383.92	365.22	22,900	5,500	28,400	31
1-May-2010	9:00	384.14	365.24	21,200	5,500	26,700	29
1-May-2010	10:00	384.55	365.45	22,400	5,500	27,900	31
1-May-2010	11:00	385.00	365.70	22,400	5,500	27,900	31
1-May-2010	12:00	385.55	365.95	24,000	5,500	29,500	33
1-May-2010	13:00	386.00	367.00	20,800	18,800	39,600	28
1-May-2010	14:00	386.20	368.80	20,700	39,000	59,700	24
1-May-2010	15:00	386.08	371.28	19,700	73,000	92,700	16
1-May-2010	16:00	386.35	373.75	11,100	68,000	79,100	6
1-May-2010	17:00	386.31	375.71	0	78,000	78,000	0
1-May-2010	18:00	386.35	377.85	0	86,000	86,000	0
1-May-2010	19:00	385.65	380.95	0	102,000	102,000	0
1-May-2010	20:00	385.38	382.68	0	107,000	107,000	0
1-May-2010	21:00	385.95	384.15	0	114,000	114,000	0
1-May-2010	22:00	386.44	385.04	0	120,000	120,000	0
1-May-2010	23:00	386.82	385.62	0	122,000	122,000	0
1-May-2010	24:00:00	387.21	386.11	0	122,000	122,000	0
2-May-2010	1:00	387.82	386.92	0	126,000	126,000	0
2-May-2010	2:00	388.41	387.31	0	126,000	126,000	0
2-May-2010	3:00	388.90	387.90	0	130,000	130,000	0
2-May-2010	4:00	389.33	388.33	0	130,000	130,000	0
2-May-2010	5:00	389.73	388.73	0	133,000	133,000	0
2-May-2010	6:00	390.10	388.90	0	133,000	133,000	0
2-May-2010	7:00	390.50	389.40	0	137,000	137,000	0
2-May-2010	8:00	390.97	389.77	0	139,000	139,000	0
2-May-2010	9:00	391.60	390.30	0	142,000	142,000	0

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Cheatham Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Turbine Discharge cfs	Cheatham Dam Gate Release cfs	Cheatham Dam Total Discharge cfs	Cheatham Dam Gross Energy mwh
2-May-2010	10:00	392.30	390.80	0	146,000	146,000	0
2-May-2010	11:00	393.00	391.40	0	148,000	148,000	0
2-May-2010	12:00	393.62	392.02	0	150,000	150,000	0
2-May-2010	13:00	394.30	393.30	0	160,000	160,000	0
2-May-2010	14:00	395.00	393.50	0	165,000	165,000	0
2-May-2010	15:00	395.62	393.92	0	170,000	170,000	0
2-May-2010	16:00	396.30	394.80	0	175,000	175,000	0
2-May-2010	17:00	396.86	395.36	0	175,000	175,000	0
2-May-2010	18:00	397.40	396.00	0	180,000	180,000	0
2-May-2010	19:00	397.80	396.40	0	185,000	185,000	0
2-May-2010	20:00	398.20	396.90	0	190,000	190,000	0
2-May-2010	21:00	398.60	397.40	0	195,000	195,000	0
2-May-2010	22:00	399.05	397.95	0	200,000	200,000	0
2-May-2010	23:00	399.45	398.35	0	200,000	200,000	0
2-May-2010	24:00:00	399.95	398.85	0	209,000	209,000	0
3-May-2010	1:00	400.48	399.38	0	220,000	220,000	0
3-May-2010	2:00	400.70	399.60	0	220,000	220,000	0
3-May-2010	3:00	401.14	400.04	0	220,000	220,000	0
3-May-2010	4:00	401.54	400.44	0	220,000	220,000	0
3-May-2010	5:00	401.85	400.75	0	220,000	220,000	0
3-May-2010	6:00	401.98	400.88	0	220,000	220,000	0
3-May-2010	7:00	402.48	401.38	0	220,000	220,000	0
3-May-2010	8:00	402.68	401.58	0	220,000	220,000	0
3-May-2010	9:00	402.89	401.79	0	220,000	220,000	0
3-May-2010	10:00	403.09	401.99	0	228,000	228,000	0
3-May-2010	11:00	403.29	402.19	0	228,000	228,000	0
3-May-2010	12:00	403.40	402.30	0	228,000	228,000	0

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Cheatham Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Turbine Discharge cfs	Cheatham Dam Gate Release cfs	Cheatham Dam Total Discharge cfs	Cheatham Dam Gross Energy mwh
3-May-2010	13:00	403.54	402.54	0	228,000	228,000	0
3-May-2010	14:00	403.66	402.66	0	230,000	230,000	0
3-May-2010	15:00	403.78	402.78	0	231,000	231,000	0
3-May-2010	16:00	403.89	402.99	0	232,000	232,000	0
3-May-2010	17:00	403.94	403.04	0	232,000	232,000	0
3-May-2010	18:00	403.99	403.09	0	232,000	232,000	0
3-May-2010	19:00	404.05	403.15	0	234,000	234,000	0
3-May-2010	20:00	404.05	403.05	0	234,000	234,000	0
3-May-2010	21:00	404.10	403.10	0	234,000	234,000	0
3-May-2010	22:00	404.15	403.15	0	240,000	240,000	0
3-May-2010	23:00	404.15	403.25	0	240,000	240,000	0
3-May-2010	24:00:00	404.15	403.25	0	240,000	240,000	0
4-May-2010	1:00	404.15	403.25	0	240,000	240,000	0
4-May-2010	2:00	404.15	403.25	0	240,000	240,000	0
4-May-2010	3:00	404.15	403.25	0	240,000	240,000	0
4-May-2010	4:00	404.10	403.20	0	240,000	240,000	0
4-May-2010	5:00	404.05	403.15	0	240,000	240,000	0
4-May-2010	6:00	404.05	403.15	0	240,000	240,000	0
4-May-2010	7:00	403.95	403.15	0	235,000	235,000	0
4-May-2010	8:00	403.91	403.11	0	235,000	235,000	0
4-May-2010	9:00	403.85	403.05	0	235,000	235,000	0
4-May-2010	10:00	403.75	402.85	0	235,000	235,000	0
4-May-2010	11:00	403.70	402.80	0	235,000	235,000	0
4-May-2010	12:00	403.70	402.80	0	235,000	235,000	0
4-May-2010	13:00	403.60	402.70	0	235,000	235,000	0
4-May-2010	14:00	403.52	402.62	0	235,000	235,000	0
4-May-2010	15:00	403.45	402.55	0	235,000	235,000	0

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Cheatham Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Turbine Discharge cfs	Cheatham Dam Gate Release cfs	Cheatham Dam Total Discharge cfs	Cheatham Dam Gross Energy mwh
4-May-2010	16:00	403.35	402.65	0	235,000	235,000	0
4-May-2010	17:00	403.30	402.60	0	235,000	235,000	0
4-May-2010	18:00	403.20	402.50	0	235,000	235,000	0
4-May-2010	19:00	403.09	402.39	0	230,000	230,000	0
4-May-2010	20:00	402.96	402.36	0	230,000	230,000	0
4-May-2010	21:00	402.85	402.25	0	230,000	230,000	0
4-May-2010	22:00	402.74	402.14	0	225,000	225,000	0
4-May-2010	23:00	402.63	402.03	0	225,000	225,000	0
4-May-2010	24:00:00	402.52	401.92	0	225,000	225,000	0
5-May-2010	1:00	402.42	401.82	0	220,000	220,000	0
5-May-2010	2:00	402.30	401.70	0	220,000	220,000	0
5-May-2010	3:00	402.15	401.55	0	220,000	220,000	0
5-May-2010	4:00	402.07	401.47	0	220,000	220,000	0
5-May-2010	5:00	401.96	401.36	0	217,000	217,000	0
5-May-2010	6:00	401.86	401.26	0	217,000	217,000	0
5-May-2010	7:00	401.75	401.15	0	217,000	217,000	0
5-May-2010	8:00	401.62	401.02	0	217,000	217,000	0
5-May-2010	9:00	401.50	401.00	0	215,000	215,000	0
5-May-2010	10:00	401.35	400.75	0	212,000	212,000	0
5-May-2010	11:00	401.25	400.65	0	212,000	212,000	0
5-May-2010	12:00	401.13	400.53	0	212,000	212,000	0
5-May-2010	13:00	401.00	400.40	0	206,000	206,000	0
5-May-2010	14:00	400.85	400.35	0	206,000	206,000	0
5-May-2010	15:00	400.75	400.15	0	206,000	206,000	0
5-May-2010	16:00	400.60	400.00	0	206,000	206,000	0
5-May-2010	17:00	400.45	399.95	0	206,000	206,000	0
5-May-2010	18:00	400.40	399.80	0	206,000	206,000	0

DRAFT

Cheatham Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Turbine Discharge cfs	Cheatham Dam Gate Release cfs	Cheatham Dam Total Discharge cfs	Cheatham Dam Gross Energy mwh
5-May-2010	19:00	400.20	399.60	0	200,000	200,000	0
5-May-2010	20:00	400.00	399.40	0	195,000	195,000	0
5-May-2010	21:00	399.83	399.23	0	190,000	190,000	0
5-May-2010	22:00	399.68	399.08	0	190,000	190,000	0
5-May-2010	23:00	399.50	398.90	0	190,000	190,000	0
5-May-2010	24:00:00	399.33	398.73	0	190,000	190,000	0
6-May-2010	1:00	399.09	398.59	0	190,000	190,000	0
6-May-2010	2:00	398.90	398.40	0	187,000	187,000	0
6-May-2010	3:00	398.72	398.22	0	187,000	187,000	0
6-May-2010	4:00	398.52	398.02	0	184,000	184,000	0
6-May-2010	5:00	398.32	397.82	0	184,000	184,000	0
6-May-2010	6:00	398.12	397.62	0	182,000	182,000	0
6-May-2010	7:00	397.92	397.32	0	182,000	182,000	0
6-May-2010	8:00	397.70	397.10	0	182,000	182,000	0
6-May-2010	9:00	397.49	396.99	0	179,000	179,000	0
6-May-2010	10:00	397.27	396.77	0	176,000	176,000	0
6-May-2010	11:00	397.05	396.55	0	173,000	173,000	0
6-May-2010	12:00	396.76	396.26	0	172,000	172,000	0
6-May-2010	13:00	396.53	396.03	0	168,000	168,000	0
6-May-2010	14:00	396.29	395.79	0	167,000	167,000	0
6-May-2010	15:00	396.02	395.52	0	166,000	166,000	0
6-May-2010	16:00	395.77	395.17	0	163,000	163,000	0
6-May-2010	17:00	395.51	395.01	0	160,000	160,000	0
6-May-2010	18:00	395.24	394.84	0	159,000	159,000	0
6-May-2010	19:00	394.94	394.44	0	155,000	155,000	0
6-May-2010	20:00	394.69	394.19	0	155,000	155,000	0
6-May-2010	21:00	394.42	393.92	0	151,000	151,000	0

DRAFT

Cheatham Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Cheatham Dam Headwater Elevation ft	Cheatham Dam Tailwater Elevation ft	Cheatham Dam Turbine Discharge cfs	Cheatham Dam Gate Release cfs	Cheatham Dam Total Discharge cfs	Cheatham Dam Gross Energy mwh
6-May-2010	22:00	394.14	393.64	0	147,000	147,000	0
6-May-2010	23:00	393.86	393.36	0	145,000	145,000	0
6-May-2010	24:00:00	393.57	393.07	0	145,000	145,000	0
7-May-2010	1:00	393.28	392.78	0	141,000	141,000	0
7-May-2010	2:00	393.00	392.50	0	140,000	140,000	0
7-May-2010	3:00	392.75	392.25	0	140,000	140,000	0
7-May-2010	4:00	392.47	391.97	0	136,000	136,000	0
7-May-2010	5:00	392.15	391.65	0	132,000	132,000	0
7-May-2010	6:00	391.87	391.47	0	130,000	130,000	0

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Barkley Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Turbine Discharge cfs	Barkley Dam Gate Release cfs	Barkley Dam Total Discharge cfs	Barkley Dam Gross Energy mwh
29-Apr-2010	1:00	360.10	312.90	32,700	9,500	42,200	115
29-Apr-2010	2:00	360.10	313.00	32,700	9,500	42,200	115
29-Apr-2010	3:00	360.10	313.10	32,400	9,500	41,900	114
29-Apr-2010	4:00	360.10	313.10	32,400	9,500	41,900	114
29-Apr-2010	5:00	360.10	313.10	32,400	9,500	41,900	114
29-Apr-2010	6:00	360.10	313.10	32,400	9,500	41,900	114
29-Apr-2010	7:00	360.10	313.20	32,700	9,500	42,200	114
29-Apr-2010	8:00	360.10	313.40	32,700	9,500	42,200	114
29-Apr-2010	9:00	360.10	313.40	32,700	9,500	42,200	114
29-Apr-2010	10:00	360.10	313.40	32,700	9,500	42,200	114
29-Apr-2010	11:00	360.10	313.40	32,700	9,500	42,200	114
29-Apr-2010	12:00	360.10	313.40	32,700	9,500	42,200	114
29-Apr-2010	13:00	360.10	313.40	32,700	9,500	42,200	114
29-Apr-2010	14:00	360.10	313.40	32,700	9,500	42,200	114
29-Apr-2010	15:00	360.10	313.40	32,700	9,500	42,200	114
29-Apr-2010	16:00	360.05	313.45	32,700	9,500	42,200	114
29-Apr-2010	17:00	360.05	313.55	32,700	9,500	42,200	114
29-Apr-2010	18:00	360.05	313.55	32,700	9,500	42,200	114
29-Apr-2010	19:00	360.05	313.65	33,000	9,500	42,500	114
29-Apr-2010	20:00	360.05	313.65	33,000	9,500	42,500	114
29-Apr-2010	21:00	360.00	313.80	33,000	9,500	42,500	114
29-Apr-2010	22:00	360.00	313.80	33,000	9,500	42,500	114
29-Apr-2010	23:00	359.95	313.85	33,000	9,500	42,500	114
29-Apr-2010	24:00:00	359.95	313.95	33,300	9,500	42,800	114
30-Apr-2010	1:00	359.95	314.05	33,300	9,500	42,800	114
30-Apr-2010	2:00	359.95	314.15	33,300	9,500	42,800	114
30-Apr-2010	3:00	359.95	314.25	33,300	9,500	42,800	114

DRAFT

Barkley Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Turbine Discharge cfs	Barkley Dam Gate Release cfs	Barkley Dam Total Discharge cfs	Barkley Dam Gross Energy mwh
30-Apr-2010	4:00	359.95	314.35	33,300	9,500	42,800	114
30-Apr-2010	5:00	359.95	314.35	33,300	9,500	42,800	114
30-Apr-2010	6:00	359.95	314.35	33,300	9,500	42,800	114
30-Apr-2010	7:00	359.95	314.45	33,600	9,500	43,100	114
30-Apr-2010	8:00	359.95	314.45	33,200	9,500	42,700	113
30-Apr-2010	9:00	359.95	314.45	33,200	9,500	42,700	113
30-Apr-2010	10:00	359.95	314.45	33,200	9,500	42,700	113
30-Apr-2010	11:00	359.95	314.45	33,200	9,500	42,700	113
30-Apr-2010	12:00	359.90	314.50	33,200	9,500	42,700	113
30-Apr-2010	13:00	359.90	314.60	33,300	9,500	42,800	113
30-Apr-2010	14:00	359.90	314.60	33,300	9,500	42,800	113
30-Apr-2010	15:00	359.90	314.60	33,300	9,500	42,800	113
30-Apr-2010	16:00	359.90	314.70	33,300	9,500	42,800	113
30-Apr-2010	17:00	359.85	314.75	33,100	9,500	42,600	112
30-Apr-2010	18:00	359.85	314.75	33,100	9,500	42,600	112
30-Apr-2010	19:00	359.80	314.80	33,100	9,500	42,600	112
30-Apr-2010	20:00	359.80	314.80	33,100	9,500	42,600	112
30-Apr-2010	21:00	359.80	314.80	33,100	9,500	42,600	112
30-Apr-2010	22:00	359.80	314.80	33,100	9,500	42,600	112
30-Apr-2010	23:00	359.75	314.85	33,300	9,500	42,800	112
30-Apr-2010	24:00:00	359.75	314.95	33,300	9,500	42,800	112
1-May-2010	1:00	359.75	315.05	33,000	9,500	42,500	111
1-May-2010	2:00	359.75	315.15	33,300	9,500	42,800	111
1-May-2010	3:00	359.75	315.25	33,300	9,500	42,800	111
1-May-2010	4:00	359.75	315.35	33,300	9,500	42,800	111
1-May-2010	5:00	359.70	315.40	33,600	9,500	43,100	111
1-May-2010	6:00	359.70	315.40	32,800	9,500	42,300	109

DRAFT

Barkley Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Turbine Discharge cfs	Barkley Dam Gate Release cfs	Barkley Dam Total Discharge cfs	Barkley Dam Gross Energy mwh
1-May-2010	7:00	359.85	315.55	32,400	9,500	41,900	108
1-May-2010	8:00	359.85	315.65	32,400	9,500	41,900	108
1-May-2010	9:00	359.90	316.00	32,700	9,500	42,200	108
1-May-2010	10:00	360.15	316.15	32,700	9,500	42,200	108
1-May-2010	11:00	360.15	316.25	32,700	9,500	42,200	108
1-May-2010	12:00	360.15	316.45	33,000	9,500	42,500	108
1-May-2010	13:00	360.25	316.55	33,000	9,500	42,500	108
1-May-2010	14:00	360.25	316.75	33,300	9,500	42,800	108
1-May-2010	15:00	360.25	316.75	33,300	9,500	42,800	108
1-May-2010	16:00	360.40	316.80	33,000	9,500	42,500	108
1-May-2010	17:00	360.55	316.95	33,000	9,600	42,600	108
1-May-2010	18:00	360.75	316.95	33,000	9,600	42,600	108
1-May-2010	19:00	360.95	316.95	32,700	9,600	42,300	108
1-May-2010	20:00	361.05	317.05	32,700	9,600	42,300	108
1-May-2010	21:00	361.25	317.05	32,400	9,700	42,100	108
1-May-2010	22:00	361.45	317.15	32,400	9,700	42,100	108
1-May-2010	23:00	361.60	317.30	32,400	9,700	42,100	108
1-May-2010	24:00:00	361.80	317.30	32,100	9,800	41,900	108
2-May-2010	1:00	362.00	317.50	32,100	9,800	41,900	108
2-May-2010	2:00	362.20	317.70	32,100	9,800	41,900	108
2-May-2010	3:00	362.50	318.00	32,100	9,900	42,000	108
2-May-2010	4:00	362.70	318.20	32,100	9,900	42,000	108
2-May-2010	5:00	362.90	318.50	32,400	9,900	42,300	108
2-May-2010	6:00	363.10	318.70	32,400	9,900	42,300	108
2-May-2010	7:00	363.25	318.85	32,400	10,000	42,400	108
2-May-2010	8:00	363.50	319.10	32,400	10,000	42,400	108
2-May-2010	9:00	363.65	319.15	32,100	10,000	42,100	108

DRAFT

Barkley Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Turbine Discharge cfs	Barkley Dam Gate Release cfs	Barkley Dam Total Discharge cfs	Barkley Dam Gross Energy mwh
2-May-2010	10:00	363.85	319.35	32,100	10,000	42,100	108
2-May-2010	11:00	364.05	319.95	32,700	15,800	48,500	108
2-May-2010	12:00	364.15	320.65	33,300	21,600	54,900	108
2-May-2010	13:00	364.30	321.30	33,600	26,000	59,600	108
2-May-2010	14:00	364.45	322.15	34,500	31,800	66,300	108
2-May-2010	15:00	364.55	323.15	35,400	39,200	74,600	108
2-May-2010	16:00	364.60	324.30	36,600	49,400	86,000	108
2-May-2010	17:00	364.65	325.35	38,100	55,200	93,300	108
2-May-2010	18:00	364.70	326.50	38,700	62,400	101,100	106
2-May-2010	19:00	364.75	328.15	39,000	71,200	110,200	102
2-May-2010	20:00	364.80	329.40	38,100	81,500	119,600	96
2-May-2010	21:00	364.85	330.65	38,600	91,800	130,400	93
2-May-2010	22:00	364.85	331.95	37,700	103,600	141,300	87
2-May-2010	23:00	364.85	333.05	38,500	112,000	150,500	85
2-May-2010	24:00:00	364.85	333.95	36,100	120,400	156,500	78
3-May-2010	1:00	364.85	335.05	36,500	130,200	166,700	75
3-May-2010	2:00	364.90	336.60	36,200	143,500	179,700	70
3-May-2010	3:00	364.85	337.35	34,700	153,200	187,900	65
3-May-2010	4:00	364.90	338.40	34,300	166,600	200,900	61
3-May-2010	5:00	364.85	339.35	30,900	179,000	209,900	53
3-May-2010	6:00	364.90	340.30	28,500	190,800	219,300	47
3-May-2010	7:00	364.95	341.25	27,300	200,600	227,900	42
3-May-2010	8:00	364.90	342.20	25,800	218,400	244,200	37
3-May-2010	9:00	364.90	343.20	23,100	228,800	251,900	30
3-May-2010	10:00	364.85	344.35	22,200	239,200	261,400	26
3-May-2010	11:00	364.90	344.80	21,500	239,200	260,700	24
3-May-2010	12:00	364.95	345.25	20,700	240,000	260,700	22

DRAFT

Barkley Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Turbine Discharge cfs	Barkley Dam Gate Release cfs	Barkley Dam Total Discharge cfs	Barkley Dam Gross Energy mwh
3-May-2010	13:00	364.95	345.85	20,500	250,400	270,900	21
3-May-2010	14:00	364.95	346.45	19,000	260,000	279,000	18
3-May-2010	15:00	364.95	347.15	12,300	276,900	289,200	11
3-May-2010	16:00	364.85	347.85	5,800	293,900	299,700	5
3-May-2010	17:00	364.90	348.40	0	300,000	300,000	0
3-May-2010	18:00	364.90	348.70	0	300,000	300,000	0
3-May-2010	19:00	364.95	349.25	0	300,000	300,000	0
3-May-2010	20:00	365.10	349.10	0	291,200	291,200	0
3-May-2010	21:00	365.15	348.95	0	280,800	280,800	0
3-May-2010	22:00	365.25	349.05	0	282,400	282,400	0
3-May-2010	23:00	365.25	349.15	0	282,400	282,400	0
3-May-2010	24:00:00	365.25	349.25	0	282,400	282,400	0
4-May-2010	1:00	365.30	349.30	0	282,400	282,400	0
4-May-2010	2:00	365.35	349.45	0	283,200	283,200	0
4-May-2010	3:00	365.45	349.55	0	283,200	283,200	0
4-May-2010	4:00	365.45	349.65	0	283,200	283,200	0
4-May-2010	5:00	365.45	350.05	0	293,600	293,600	0
4-May-2010	6:00	365.45	350.05	0	293,600	293,600	0
4-May-2010	7:00	365.50	350.40	0	296,000	296,000	0
4-May-2010	8:00	365.45	350.75	0	303,200	303,200	0
4-May-2010	9:00	365.60	350.60	0	285,800	285,800	0
4-May-2010	10:00	365.70	350.40	0	266,000	266,000	0
4-May-2010	11:00	365.70	350.30	0	266,000	266,000	0
4-May-2010	12:00	365.70	350.30	0	266,000	266,000	0
4-May-2010	13:00	365.80	350.40	0	266,000	266,000	0
4-May-2010	14:00	365.80	350.40	0	266,000	266,000	0
4-May-2010	15:00	365.80	350.40	0	266,700	266,700	0

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Barkley Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Turbine Discharge cfs	Barkley Dam Gate Release cfs	Barkley Dam Total Discharge cfs	Barkley Dam Gross Energy mwh
4-May-2010	16:00	365.85	350.35	0	266,700	266,700	0
4-May-2010	17:00	366.05	349.75	0	249,300	249,300	0
4-May-2010	18:00	366.10	349.50	0	229,800	229,800	0
4-May-2010	19:00	366.15	349.25	0	230,400	230,400	0
4-May-2010	20:00	366.15	349.15	0	230,400	230,400	0
4-May-2010	21:00	366.25	349.05	0	231,000	231,000	0
4-May-2010	22:00	366.25	349.05	0	231,000	231,000	0
4-May-2010	23:00	366.30	349.00	0	231,000	231,000	0
4-May-2010	24:00:00	366.35	348.95	0	231,000	231,000	0
5-May-2010	1:00	366.35	348.85	0	231,000	231,000	0
5-May-2010	2:00	366.40	348.80	0	231,000	231,000	0
5-May-2010	3:00	366.45	348.75	0	231,600	231,600	0
5-May-2010	4:00	366.50	348.70	0	231,600	231,600	0
5-May-2010	5:00	366.50	348.70	0	231,600	231,600	0
5-May-2010	6:00	366.55	348.65	0	232,200	232,200	0
5-May-2010	7:00	366.60	348.70	0	232,200	232,200	0
5-May-2010	8:00	366.60	348.70	0	232,200	232,200	0
5-May-2010	9:00	366.65	348.65	0	232,200	232,200	0
5-May-2010	10:00	366.65	348.65	0	232,200	232,200	0
5-May-2010	11:00	366.70	348.60	0	232,200	232,200	0
5-May-2010	12:00	366.70	348.60	0	232,200	232,200	0
5-May-2010	13:00	366.75	348.55	0	232,200	232,200	0
5-May-2010	14:00	366.80	348.60	0	232,800	232,800	0
5-May-2010	15:00	366.85	348.55	0	232,800	232,800	0
5-May-2010	16:00	366.85	348.55	0	232,800	232,800	0
5-May-2010	17:00	366.90	348.60	0	232,800	232,800	0
5-May-2010	18:00	366.90	348.60	0	232,800	232,800	0

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Barkley Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Turbine Discharge cfs	Barkley Dam Gate Release cfs	Barkley Dam Total Discharge cfs	Barkley Dam Gross Energy mwh
5-May-2010	19:00	366.95	348.65	0	233,400	233,400	0
5-May-2010	20:00	366.95	348.65	0	233,400	233,400	0
5-May-2010	21:00	366.95	348.65	0	233,400	233,400	0
5-May-2010	22:00	366.95	348.65	0	233,400	233,400	0
5-May-2010	23:00	367.00	348.70	0	233,400	233,400	0
5-May-2010	24:00:00	367.00	348.70	0	233,400	233,400	0
6-May-2010	1:00	367.00	348.70	0	233,400	233,400	0
6-May-2010	2:00	367.00	348.70	0	233,400	233,400	0
6-May-2010	3:00	367.00	348.70	0	233,400	233,400	0
6-May-2010	4:00	367.00	348.70	0	233,400	233,400	0
6-May-2010	5:00	367.00	348.70	0	233,400	233,400	0
6-May-2010	6:00	367.00	348.70	0	233,400	233,400	0
6-May-2010	7:00	367.00	348.70	0	233,400	233,400	0
6-May-2010	8:00	367.00	348.80	0	233,400	233,400	0
6-May-2010	9:00	367.05	348.85	0	233,400	233,400	0
6-May-2010	10:00	367.05	348.85	0	233,400	233,400	0
6-May-2010	11:00	367.15	348.65	0	226,800	226,800	0
6-May-2010	12:00	367.15	348.25	0	219,000	219,000	0
6-May-2010	13:00	367.25	348.25	0	219,000	219,000	0
6-May-2010	14:00	367.45	347.45	0	207,900	207,900	0
6-May-2010	15:00	367.55	347.35	0	198,600	198,600	0
6-May-2010	16:00	367.65	347.15	0	187,900	187,900	0
6-May-2010	17:00	367.75	346.55	0	177,500	177,500	0
6-May-2010	18:00	367.75	345.95	0	165,400	165,400	0
6-May-2010	19:00	368.00	345.00	0	158,400	158,400	0
6-May-2010	20:00	368.05	344.65	0	150,400	150,400	0
6-May-2010	21:00	368.15	344.35	0	150,600	150,600	0

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Barkley Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Barkley Dam Headwater Elevation ft	Barkley Dam Tailwater Elevation ft	Barkley Dam Turbine Discharge cfs	Barkley Dam Gate Release cfs	Barkley Dam Total Discharge cfs	Barkley Dam Gross Energy mwh
6-May-2010	22:00	368.20	343.80	0	150,800	150,800	0
6-May-2010	23:00	368.30	343.60	0	151,000	151,000	0
6-May-2010	24:00:00	368.30	343.60	0	151,000	151,000	0
7-May-2010	1:00	368.40	343.00	0	151,200	151,200	0
7-May-2010	2:00	368.45	342.65	0	151,200	151,200	0
7-May-2010	3:00	368.50	342.30	0	151,600	151,600	0
7-May-2010	4:00	368.55	342.15	0	151,600	151,600	0
7-May-2010	5:00	368.60	341.90	0	151,800	151,800	0
7-May-2010	6:00	368.65	341.85	0	151,800	151,800	0

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Center Hill Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Center Hill Dam Headwater Elevation ft	Center Hill Dam Tailwater Elevation ft	Center Hill Dam Turbine Discharge cfs	Center Hill Dam Sluice Gate Release cfs	Center Hill Dam Total Discharge cfs	Center Hill Dam Gross Energy mwh
29-Apr-2010	1:00	630.44	476.94	0	250	250	0
29-Apr-2010	2:00	630.44	476.34	0	250	250	0
29-Apr-2010	3:00	630.44	476.14	0	250	250	0
29-Apr-2010	4:00	630.45	476.15	0	250	250	0
29-Apr-2010	5:00	630.45	476.75	0	250	250	0
29-Apr-2010	6:00	630.45	479.75	3,400	250	3,650	40
29-Apr-2010	7:00	630.46	480.36	3,400	250	3,650	40
29-Apr-2010	8:00	630.45	480.55	3,400	250	3,650	40
29-Apr-2010	9:00	630.45	480.65	3,400	250	3,650	40
29-Apr-2010	10:00	630.43	480.83	3,400	250	3,650	40
29-Apr-2010	11:00	630.43	477.83	0	250	250	0
29-Apr-2010	12:00	630.43	476.73	0	250	250	0
29-Apr-2010	13:00	630.43	476.33	0	250	250	0
29-Apr-2010	14:00	630.43	476.33	0	250	250	0
29-Apr-2010	15:00	630.43	480.13	3,400	250	3,650	40
29-Apr-2010	16:00	630.43	480.53	3,400	250	3,650	40
29-Apr-2010	17:00	630.42	480.72	3,400	250	3,650	40
29-Apr-2010	18:00	630.41	480.81	3,400	250	3,650	40
29-Apr-2010	19:00	630.40	480.90	3,400	250	3,650	40
29-Apr-2010	20:00	630.40	480.90	3,400	250	3,650	40
29-Apr-2010	21:00	630.40	480.90	3,400	250	3,650	40
29-Apr-2010	22:00	630.40	478.00	0	250	250	0
29-Apr-2010	23:00	630.40	476.90	0	250	250	0
29-Apr-2010	24:00:00	630.40	476.40	0	250	250	0
30-Apr-2010	1:00	630.42	476.12	0	250	250	0
30-Apr-2010	2:00	630.42	476.12	0	250	250	0
30-Apr-2010	3:00	630.42	476.02	0	250	250	0

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Center Hill Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Center Hill Dam Headwater Elevation ft	Center Hill Dam Tailwater Elevation ft	Center Hill Dam Turbine Discharge cfs	Center Hill Dam Sluice Gate Release cfs	Center Hill Dam Total Discharge cfs	Center Hill Dam Gross Energy mwh
30-Apr-2010	4:00	630.42	476.02	0	250	250	0
30-Apr-2010	5:00	630.42	476.02	0	250	250	0
30-Apr-2010	6:00	630.42	476.02	0	250	250	0
30-Apr-2010	7:00	630.44	476.04	0	250	250	0
30-Apr-2010	8:00	630.44	476.04	0	250	250	0
30-Apr-2010	9:00	630.44	476.14	0	250	250	0
30-Apr-2010	10:00	630.46	476.06	0	250	250	0
30-Apr-2010	11:00	630.46	480.16	3,400	250	3,650	40
30-Apr-2010	12:00	630.45	480.55	3,400	250	3,650	40
30-Apr-2010	13:00	630.45	480.75	3,400	250	3,650	40
30-Apr-2010	14:00	630.44	480.94	3,400	250	3,650	40
30-Apr-2010	15:00	630.43	480.93	3,400	250	3,650	40
30-Apr-2010	16:00	630.43	480.93	3,400	250	3,650	40
30-Apr-2010	17:00	630.42	480.92	3,400	250	3,650	40
30-Apr-2010	18:00	630.42	480.92	3,400	250	3,650	40
30-Apr-2010	19:00	630.41	480.91	3,400	250	3,650	40
30-Apr-2010	20:00	630.41	480.91	3,400	250	3,650	40
30-Apr-2010	21:00	630.41	480.91	3,400	250	3,650	40
30-Apr-2010	22:00	630.41	480.91	3,400	250	3,650	40
30-Apr-2010	23:00	630.41	478.41	0	250	250	0
30-Apr-2010	24:00:00	630.41	477.91	0	250	250	0
1-May-2010	1:00	630.42	476.12	0	250	250	0
1-May-2010	2:00	630.42	476.12	0	250	250	0
1-May-2010	3:00	630.44	476.04	0	250	250	0
1-May-2010	4:00	630.44	476.04	0	250	250	0
1-May-2010	5:00	630.44	476.04	0	250	250	0
1-May-2010	6:00	630.44	476.04	0	250	250	0

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Center Hill Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Center Hill Dam Headwater Elevation ft	Center Hill Dam Tailwater Elevation ft	Center Hill Dam Turbine Discharge cfs	Center Hill Dam Sluice Gate Release cfs	Center Hill Dam Total Discharge cfs	Center Hill Dam Gross Energy mwh
1-May-2010	7:00	630.46	476.06	0	250	250	0
1-May-2010	8:00	630.46	476.06	0	250	250	0
1-May-2010	9:00	630.46	476.06	0	250	250	0
1-May-2010	10:00	630.46	476.06	0	250	250	0
1-May-2010	11:00	630.58	480.28	3,400	250	3,650	40
1-May-2010	12:00	630.61	480.71	3,400	250	3,650	40
1-May-2010	13:00	630.65	480.85	3,400	250	3,650	40
1-May-2010	14:00	630.61	481.01	3,400	250	3,650	40
1-May-2010	15:00	630.65	481.05	3,400	250	3,650	40
1-May-2010	16:00	630.65	481.25	3,400	250	3,650	40
1-May-2010	17:00	630.70	481.90	3,500	250	3,750	40
1-May-2010	18:00	630.73	482.43	3,500	250	3,750	40
1-May-2010	19:00	630.85	482.55	3,500	250	3,750	40
1-May-2010	20:00	631.07	482.87	3,500	250	3,750	40
1-May-2010	21:00	631.15	483.65	3,500	250	3,750	40
1-May-2010	22:00	631.15	483.75	3,500	250	3,750	40
1-May-2010	23:00	631.25	484.05	3,500	250	3,750	40
1-May-2010	24:00:00	631.33	484.23	3,500	250	3,750	40
2-May-2010	1:00	631.35	484.35	3,500	250	3,750	40
2-May-2010	2:00	631.35	484.55	3,500	250	3,750	40
2-May-2010	3:00	631.40	484.60	3,500	250	3,750	40
2-May-2010	4:00	631.45	484.65	3,500	250	3,750	40
2-May-2010	5:00	631.50	484.70	3,500	250	3,750	40
2-May-2010	6:00	631.70	485.10	3,500	250	3,750	40
2-May-2010	7:00	631.94	485.34	3,500	250	3,750	40
2-May-2010	8:00	632.20	485.40	3,500	250	3,750	40
2-May-2010	9:00	632.48	485.38	3,500	250	3,750	40

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Center Hill Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Center Hill Dam Headwater Elevation ft	Center Hill Dam Tailwater Elevation ft	Center Hill Dam Turbine Discharge cfs	Center Hill Dam Sluice Gate Release cfs	Center Hill Dam Total Discharge cfs	Center Hill Dam Gross Energy mwh
2-May-2010	10:00	632.75	485.35	3,500	250	3,750	40
2-May-2010	11:00	633.01	485.01	3,500	250	3,750	40
2-May-2010	12:00	633.24	484.54	3,500	250	3,750	40
2-May-2010	13:00	633.50	483.90	3,400	250	3,650	40
2-May-2010	14:00	633.93	483.43	3,400	250	3,650	40
2-May-2010	15:00	633.99	483.04	3,400	250	3,650	40
2-May-2010	16:00	634.17	482.77	3,400	250	3,650	40
2-May-2010	17:00	634.39	482.89	3,400	250	3,650	40
2-May-2010	18:00	634.64	482.94	3,400	250	3,650	40
2-May-2010	19:00	634.93	483.93	3,400	250	3,650	40
2-May-2010	20:00	635.16	484.86	3,400	250	3,650	40
2-May-2010	21:00	635.46	486.16	3,400	250	3,650	40
2-May-2010	22:00	635.80	486.50	0	250	250	0
2-May-2010	23:00	636.12	487.12	0	250	250	0
2-May-2010	24:00:00	636.51	487.71	0	250	250	0
3-May-2010	1:00	636.89	488.09	0	250	250	0
3-May-2010	2:00	637.24	488.44	0	250	250	0
3-May-2010	3:00	637.54	488.74	0	250	250	0
3-May-2010	4:00	637.82	489.12	0	250	250	0
3-May-2010	5:00	638.11	489.71	0	250	250	0
3-May-2010	6:00	638.38	490.38	0	250	250	0
3-May-2010	7:00	638.66	490.96	0	250	250	0
3-May-2010	8:00	638.92	491.42	0	250	250	0
3-May-2010	9:00	639.21	491.71	0	250	250	0
3-May-2010	10:00	639.49	491.99	0	250	250	0
3-May-2010	11:00	639.78	492.08	0	250	250	0
3-May-2010	12:00	640.06	491.96	0	250	250	0

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Center Hill Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Center Hill Dam Headwater Elevation ft	Center Hill Dam Tailwater Elevation ft	Center Hill Dam Turbine Discharge cfs	Center Hill Dam Sluice Gate Release cfs	Center Hill Dam Total Discharge cfs	Center Hill Dam Gross Energy mwh
3-May-2010	13:00	640.36	491.76	0	250	250	0
3-May-2010	14:00	640.60	491.50	0	250	250	0
3-May-2010	15:00	640.93	491.13	0	250	250	0
3-May-2010	16:00	641.21	490.71	0	250	250	0
3-May-2010	17:00	641.52	490.02	0	250	250	0
3-May-2010	18:00	641.78	489.48	0	250	250	0
3-May-2010	19:00	642.07	488.77	0	250	250	0
3-May-2010	20:00	642.28	488.28	0	250	250	0
3-May-2010	21:00	642.60	487.40	0	250	250	0
3-May-2010	22:00	642.83	486.93	0	250	250	0
3-May-2010	23:00	643.08	486.38	0	250	250	0
3-May-2010	24:00:00	643.30	485.80	0	250	250	0
4-May-2010	1:00	643.54	486.04	3,200	250	3,450	40
4-May-2010	2:00	643.75	485.75	3,200	250	3,450	40
4-May-2010	3:00	643.95	485.55	3,200	250	3,450	40
4-May-2010	4:00	644.14	485.24	3,200	250	3,450	40
4-May-2010	5:00	644.31	484.81	3,200	250	3,450	40
4-May-2010	6:00	644.48	484.48	3,200	250	3,450	40
4-May-2010	7:00	644.63	484.13	3,200	250	3,450	40
4-May-2010	8:00	644.78	483.78	3,200	250	3,450	40
4-May-2010	9:00	644.92	483.42	3,200	250	3,450	40
4-May-2010	10:00	645.07	483.07	3,100	250	3,350	40
4-May-2010	11:00	645.17	482.77	3,100	250	3,350	40
4-May-2010	12:00	645.30	482.50	3,100	250	3,350	40
4-May-2010	13:00	645.40	482.20	3,100	250	3,350	40
4-May-2010	14:00	645.49	481.99	3,100	250	3,350	40
4-May-2010	15:00	645.47	481.77	3,100	250	3,350	40

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Center Hill Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Center Hill Dam Headwater Elevation ft	Center Hill Dam Tailwater Elevation ft	Center Hill Dam Turbine Discharge cfs	Center Hill Dam Sluice Gate Release cfs	Center Hill Dam Total Discharge cfs	Center Hill Dam Gross Energy mwh
4-May-2010	16:00	645.56	481.66	3,100	250	3,350	40
4-May-2010	17:00	645.66	481.56	3,100	250	3,350	40
4-May-2010	18:00	645.70	481.40	3,100	250	3,350	40
4-May-2010	19:00	645.73	481.33	3,100	250	3,350	40
4-May-2010	20:00	645.85	481.25	3,100	250	3,350	40
4-May-2010	21:00	645.91	481.11	3,100	250	3,350	40
4-May-2010	22:00	645.95	481.05	3,100	250	3,350	40
4-May-2010	23:00	646.02	481.02	3,100	250	3,350	40
4-May-2010	24:00:00	646.11	480.91	3,100	250	3,350	40
5-May-2010	1:00	646.15	480.85	3,100	250	3,350	40
5-May-2010	2:00	646.19	480.69	3,100	250	3,350	40
5-May-2010	3:00	646.27	480.67	3,100	250	3,350	40
5-May-2010	4:00	646.34	480.64	3,100	250	3,350	40
5-May-2010	5:00	646.37	480.57	3,100	250	3,350	40
5-May-2010	6:00	646.43	480.63	3,100	250	3,350	40
5-May-2010	7:00	646.50	480.60	3,100	250	3,350	40
5-May-2010	8:00	646.54	480.64	3,100	250	3,350	40
5-May-2010	9:00	646.58	480.58	3,100	250	3,350	40
5-May-2010	10:00	646.63	480.63	3,100	250	3,350	40
5-May-2010	11:00	646.68	480.68	3,100	250	3,350	40
5-May-2010	12:00	646.72	480.62	3,100	250	3,350	40
5-May-2010	13:00	646.75	482.55	5,700	250	5,950	72
5-May-2010	14:00	646.76	483.16	6,200	250	6,450	80
5-May-2010	15:00	646.71	486.21	12,000	250	12,250	147
5-May-2010	16:00	646.70	487.10	11,400	250	11,650	142
5-May-2010	17:00	646.70	487.40	11,600	250	11,850	144
5-May-2010	18:00	646.65	487.65	12,200	250	12,450	148

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Center Hill Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Center Hill Dam Headwater Elevation ft	Center Hill Dam Tailwater Elevation ft	Center Hill Dam Turbine Discharge cfs	Center Hill Dam Sluice Gate Release cfs	Center Hill Dam Total Discharge cfs	Center Hill Dam Gross Energy mwh
5-May-2010	19:00	646.60	487.90	11,700	250	11,950	143
5-May-2010	20:00	646.60	488.30	12,400	250	12,650	150
5-May-2010	21:00	646.57	488.37	12,400	250	12,650	150
5-May-2010	22:00	646.53	488.53	12,400	250	12,650	150
5-May-2010	23:00	646.50	488.60	12,700	250	12,950	152
5-May-2010	24:00:00	646.48	488.68	12,700	250	12,950	152
6-May-2010	1:00	646.44	488.74	12,600	250	12,850	150
6-May-2010	2:00	646.41	488.71	12,600	250	12,850	150
6-May-2010	3:00	646.38	488.78	12,700	250	12,950	151
6-May-2010	4:00	646.35	488.75	12,700	250	12,950	151
6-May-2010	5:00	646.31	488.81	12,800	250	13,050	152
6-May-2010	6:00	646.28	488.88	12,800	250	13,050	152
6-May-2010	7:00	646.25	488.85	12,400	250	12,650	148
6-May-2010	8:00	646.22	488.82	13,100	250	13,350	154
6-May-2010	9:00	646.17	488.17	12,600	250	12,850	151
6-May-2010	10:00	646.15	488.85	12,400	250	12,650	148
6-May-2010	11:00	646.13	488.85	13,000	250	13,250	153
6-May-2010	12:00	646.10	488.90	12,900	250	13,150	152
6-May-2010	13:00	646.08	489.58	12,500	1,400	13,900	147
6-May-2010	14:00	646.03	490.13	13,100	3,400	16,500	152
6-May-2010	15:00	645.98	490.38	12,600	3,400	16,000	147
6-May-2010	16:00	645.94	490.54	12,600	3,400	16,000	147
6-May-2010	17:00	645.90	490.70	12,900	3,400	16,300	150
6-May-2010	18:00	645.91	490.61	12,600	3,400	16,000	147
6-May-2010	19:00	645.82	490.72	12,700	3,400	16,100	147
6-May-2010	20:00	645.79	490.69	12,500	3,400	15,900	145
6-May-2010	21:00	645.75	490.75	12,700	3,400	16,100	147

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Center Hill Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Center Hill Dam Headwater Elevation ft	Center Hill Dam Tailwater Elevation ft	Center Hill Dam Turbine Discharge cfs	Center Hill Dam Sluice Gate Release cfs	Center Hill Dam Total Discharge cfs	Center Hill Dam Gross Energy mwh
6-May-2010	22:00	645.71	490.81	12,700	3,400	16,100	147
6-May-2010	23:00	645.67	490.87	12,600	3,400	16,000	146
6-May-2010	24:00:00	645.63	490.83	12,600	3,400	16,000	146
7-May-2010	1:00	645.58	490.78	12,600	3,400	16,000	146
7-May-2010	2:00	645.54	490.74	12,600	3,400	16,000	146
7-May-2010	3:00	645.50	490.70	12,500	3,400	15,900	145
7-May-2010	4:00	645.46	490.76	12,500	3,400	15,900	145
7-May-2010	5:00	645.41	490.81	12,600	3,400	16,000	146
7-May-2010	6:00	645.37	490.87	12,600	3,400	16,000	146
7-May-2010	7:00	645.32	490.82	12,600	3,400	16,000	146
7-May-2010	8:00	645.28	490.78	12,600	3,400	16,000	146

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Dale Hollow Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Tailwater Elevation ft	Dale Hollow Dam Turbine Discharge cfs	Dale Hollow Dam Gate Release cfs	Dale Hollow Dam Total Discharge cfs	Dale Hollow Dam Gross Energy mwh
29-Apr-2010	1:00	650.32	510.20	1,720	25	1,745	18
29-Apr-2010	2:00	650.32	510.20	1,720	25	1,745	18
29-Apr-2010	3:00	650.32	510.20	1,720	25	1,745	18
29-Apr-2010	4:00	650.32	510.20	1,720	25	1,745	18
29-Apr-2010	5:00	650.32	510.20	1,720	25	1,745	18
29-Apr-2010	6:00	650.32	510.20	1,720	25	1,745	18
29-Apr-2010	7:00	650.31	510.30	1,770	25	1,795	18
29-Apr-2010	8:00	650.31	510.30	1,770	25	1,795	18
29-Apr-2010	9:00	650.30	510.40	1,770	25	1,795	18
29-Apr-2010	10:00	650.30	510.40	1,770	25	1,795	19
29-Apr-2010	11:00	650.30	510.30	1,720	25	1,745	18
29-Apr-2010	12:00	650.30	510.30	1,720	25	1,745	18
29-Apr-2010	13:00	650.29	510.30	1,720	25	1,745	18
29-Apr-2010	14:00	650.29	510.30	1,720	25	1,745	18
29-Apr-2010	15:00	650.28	510.40	1,720	25	1,745	18
29-Apr-2010	16:00	650.28	510.40	1,720	25	1,745	18
29-Apr-2010	17:00	650.28	510.50	1,720	25	1,745	18
29-Apr-2010	18:00	650.27	510.50	1,720	25	1,745	18
29-Apr-2010	19:00	650.27	510.40	1,720	25	1,745	18
29-Apr-2010	20:00	650.27	510.40	1,720	25	1,745	18
29-Apr-2010	21:00	650.27	510.40	1,720	25	1,745	18
29-Apr-2010	22:00	650.27	510.40	1,720	25	1,745	18
29-Apr-2010	23:00	650.27	510.40	1,720	25	1,745	18
29-Apr-2010	24:00:00	650.26	510.40	1,720	25	1,745	18
30-Apr-2010	1:00	650.26	510.40	1,720	25	1,745	18
30-Apr-2010	2:00	650.26	510.40	1,720	25	1,745	18
30-Apr-2010	3:00	650.25	510.40	1,720	25	1,745	18

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Dale Hollow Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Tailwater Elevation ft	Dale Hollow Dam Turbine Discharge cfs	Dale Hollow Dam Gate Release cfs	Dale Hollow Dam Total Discharge cfs	Dale Hollow Dam Gross Energy mwh
30-Apr-2010	4:00	650.25	510.40	1,720	25	1,745	18
30-Apr-2010	5:00	650.25	510.40	1,720	25	1,745	18
30-Apr-2010	6:00	650.25	510.40	1,720	25	1,745	18
30-Apr-2010	7:00	650.24	510.30	1,720	25	1,745	18
30-Apr-2010	8:00	650.24	510.30	1,720	25	1,745	18
30-Apr-2010	9:00	650.23	510.30	1,720	25	1,745	18
30-Apr-2010	10:00	650.22	510.40	1,720	25	1,745	18
30-Apr-2010	11:00	650.22	510.40	1,720	25	1,745	18
30-Apr-2010	12:00	650.21	510.50	1,720	25	1,745	18
30-Apr-2010	13:00	650.21	510.50	1,720	25	1,745	18
30-Apr-2010	14:00	650.20	510.50	1,720	25	1,745	18
30-Apr-2010	15:00	650.20	510.50	1,720	25	1,745	18
30-Apr-2010	16:00	650.19	510.50	1,720	25	1,745	18
30-Apr-2010	17:00	650.19	510.50	1,720	25	1,745	18
30-Apr-2010	18:00	650.19	510.50	1,720	25	1,745	18
30-Apr-2010	19:00	650.19	510.40	1,720	25	1,745	18
30-Apr-2010	20:00	650.18	510.40	1,720	25	1,745	18
30-Apr-2010	21:00	650.18	510.40	1,720	25	1,745	18
30-Apr-2010	22:00	650.18	510.40	1,720	25	1,745	18
30-Apr-2010	23:00	650.18	510.40	1,720	25	1,745	18
30-Apr-2010	24:00:00	650.17	510.40	1,720	25	1,745	18
1-May-2010	1:00	650.17	510.40	1,720	25	1,745	18
1-May-2010	2:00	650.17	510.40	1,720	25	1,745	18
1-May-2010	3:00	650.17	510.40	1,720	25	1,745	18
1-May-2010	4:00	650.16	510.40	1,745	25	1,770	18
1-May-2010	5:00	650.16	510.40	1,770	25	1,795	18
1-May-2010	6:00	650.16	510.40	1,770	25	1,795	18

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Dale Hollow Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Tailwater Elevation ft	Dale Hollow Dam Turbine Discharge cfs	Dale Hollow Dam Gate Release cfs	Dale Hollow Dam Total Discharge cfs	Dale Hollow Dam Gross Energy mwh
1-May-2010	7:00	650.15	510.50	1,770	25	1,795	18
1-May-2010	8:00	650.14	510.50	1,770	25	1,795	19
1-May-2010	9:00	650.14	510.50	1,770	25	1,795	18
1-May-2010	10:00	650.14	510.50	1,770	25	1,795	18
1-May-2010	11:00	650.15	510.50	1,770	25	1,795	19
1-May-2010	12:00	650.16	510.50	1,770	25	1,795	18
1-May-2010	13:00	650.18	510.50	1,770	25	1,795	18
1-May-2010	14:00	650.18	510.60	1,770	25	1,795	18
1-May-2010	15:00	650.20	510.60	1,770	25	1,795	19
1-May-2010	16:00	650.22	510.90	1,770	25	1,795	18
1-May-2010	17:00	650.24	511.50	1,790	25	1,815	18
1-May-2010	18:00	650.35	512.30	1,800	25	1,825	19
1-May-2010	19:00	650.45	513.20	1,820	25	1,845	18
1-May-2010	20:00	650.59	514.20	1,830	25	1,855	18
1-May-2010	21:00	650.71	515.00	1,830	25	1,855	18
1-May-2010	22:00	650.83	515.60	1,850	25	1,875	19
1-May-2010	23:00	650.97	515.90	1,210	25	1,235	11
1-May-2010	24:00:00	651.07	516.30	1,120	25	1,145	10
2-May-2010	1:00	651.20	516.90	1,310	25	1,335	12
2-May-2010	2:00	651.31	517.10	1,860	25	1,885	19
2-May-2010	3:00	651.42	517.30	1,860	25	1,885	18
2-May-2010	4:00	651.53	517.40	1,860	25	1,885	18
2-May-2010	5:00	651.62	517.50	1,860	25	1,885	18
2-May-2010	6:00	651.72	517.50	1,860	25	1,885	19
2-May-2010	7:00	651.78	517.50	1,860	25	1,885	18
2-May-2010	8:00	651.86	517.50	1,850	25	1,875	18
2-May-2010	9:00	651.91	517.40	1,850	25	1,875	19

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Dale Hollow Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Tailwater Elevation ft	Dale Hollow Dam Turbine Discharge cfs	Dale Hollow Dam Gate Release cfs	Dale Hollow Dam Total Discharge cfs	Dale Hollow Dam Gross Energy mwh
2-May-2010	10:00	651.99	517.40	1,850	25	1,875	18
2-May-2010	11:00	652.03	517.50	1,850	25	1,875	18
2-May-2010	12:00	652.07	517.50	1,850	25	1,875	18
2-May-2010	13:00	652.14	517.60	1,800	25	1,825	19
2-May-2010	14:00	652.18	517.60	1,800	25	1,825	18
2-May-2010	15:00	652.22	518.00	1,810	25	1,835	18
2-May-2010	16:00	652.27	518.60	1,820	25	1,845	19
2-May-2010	17:00	652.39	518.50	1,880	25	1,905	18
2-May-2010	18:00	652.52	521.80	1,940	25	1,965	19
2-May-2010	19:00	652.79	523.80	1,960	25	1,985	18
2-May-2010	20:00	653.15	524.70	1,980	25	2,005	18
2-May-2010	21:00	653.47	525.80	1,750	25	1,775	16
2-May-2010	22:00	653.73	526.30	1,750	25	1,775	17
2-May-2010	23:00	653.87	526.60	1,750	25	1,775	16
2-May-2010	24:00:00	654.12	526.70	50	25	75	0
3-May-2010	1:00	654.36	527.10	50	25	75	0
3-May-2010	2:00	654.59	527.30	50	25	75	1
3-May-2010	3:00	654.78	527.50	50	25	75	0
3-May-2010	4:00	654.94	527.60	50	25	75	0
3-May-2010	5:00	655.10	527.70	50	25	75	0
3-May-2010	6:00	655.34	527.73	50	25	75	1
3-May-2010	7:00	655.47	527.75	50	25	75	0
3-May-2010	8:00	655.62	527.70	50	25	75	0
3-May-2010	9:00	655.77	527.69	50	25	75	0
3-May-2010	10:00	655.90	527.41	50	25	75	1
3-May-2010	11:00	656.01	527.27	50	25	75	0
3-May-2010	12:00	656.12	527.00	50	25	75	0

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Dale Hollow Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Tailwater Elevation ft	Dale Hollow Dam Turbine Discharge cfs	Dale Hollow Dam Gate Release cfs	Dale Hollow Dam Total Discharge cfs	Dale Hollow Dam Gross Energy mwh
3-May-2010	13:00	656.26	526.51	50	25	75	1
3-May-2010	14:00	656.37	526.33	50	25	75	0
3-May-2010	15:00	656.39	526.00	50	25	75	0
3-May-2010	16:00	656.44	525.80	1,940	25	1,965	16
3-May-2010	17:00	656.50	525.30	1,920	25	1,945	17
3-May-2010	18:00	656.55	524.80	1,690	25	1,715	16
3-May-2010	19:00	656.59	524.40	1,690	25	1,715	16
3-May-2010	20:00	656.63	523.90	1,670	25	1,695	16
3-May-2010	21:00	656.71	522.80	1,660	25	1,685	17
3-May-2010	22:00	656.71	522.80	1,660	25	1,685	17
3-May-2010	23:00	656.74	521.70	1,650	25	1,675	16
3-May-2010	24:00:00	656.78	521.70	1,650	25	1,675	16
4-May-2010	1:00	656.81	521.70	1,630	25	1,655	16
4-May-2010	2:00	656.83	520.40	1,630	25	1,655	16
4-May-2010	3:00	656.86	519.80	1,630	25	1,655	16
4-May-2010	4:00	656.89	519.20	1,620	25	1,645	16
4-May-2010	5:00	656.92	518.60	1,620	25	1,645	17
4-May-2010	6:00	656.94	518.00	1,600	25	1,625	16
4-May-2010	7:00	656.97	517.50	1,600	25	1,625	16
4-May-2010	8:00	656.98	516.80	1,540	25	1,565	16
4-May-2010	9:00	657.00	516.30	1,540	25	1,565	16
4-May-2010	10:00	657.02	515.70	1,530	25	1,555	16
4-May-2010	11:00	657.04	515.17	1,520	25	1,545	16
4-May-2010	12:00	657.06	514.70	1,520	25	1,545	16
4-May-2010	13:00	657.07	514.20	1,510	25	1,535	16
4-May-2010	14:00	657.09	513.80	1,500	25	1,525	16
4-May-2010	15:00	657.10	513.70	1,500	25	1,525	16

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Dale Hollow Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Tailwater Elevation ft	Dale Hollow Dam Turbine Discharge cfs	Dale Hollow Dam Gate Release cfs	Dale Hollow Dam Total Discharge cfs	Dale Hollow Dam Gross Energy mwh
4-May-2010	16:00	657.12	513.40	1,500	25	1,525	16
4-May-2010	17:00	657.13	513.00	1,550	25	1,575	16
4-May-2010	18:00	657.14	512.20	1,490	25	1,515	16
4-May-2010	19:00	657.16	511.80	1,490	25	1,515	16
4-May-2010	20:00	657.17	511.60	1,480	25	1,505	16
4-May-2010	21:00	657.18	511.30	1,480	25	1,505	16
4-May-2010	22:00	657.20	511.00	1,480	25	1,505	16
4-May-2010	23:00	657.21	510.80	1,470	25	1,495	16
4-May-2010	24:00:00	657.22	510.70	1,470	25	1,495	16
5-May-2010	1:00	657.23	510.50	1,470	25	1,495	16
5-May-2010	2:00	657.24	510.30	1,470	25	1,495	16
5-May-2010	3:00	657.25	510.20	1,470	25	1,495	16
5-May-2010	4:00	657.26	510.20	1,470	25	1,495	16
5-May-2010	5:00	657.27	510.10	1,470	25	1,495	16
5-May-2010	6:00	657.28	510.00	1,470	1,495	2,965	16
5-May-2010	7:00	657.28	509.90	1,470	1,495	2,965	16
5-May-2010	8:00	657.30	509.80	1,470	25	1,495	16
5-May-2010	9:00	657.31	509.80	1,470	25	1,495	16
5-May-2010	10:00	657.31	509.70	1,470	25	1,495	16
5-May-2010	11:00	657.32	509.70	1,470	25	1,495	16
5-May-2010	12:00	657.32	509.70	1,470	25	1,495	16
5-May-2010	13:00	657.32	511.60	2,960	25	2,985	32
5-May-2010	14:00	657.32	512.10	2,980	25	3,005	32
5-May-2010	15:00	657.33	512.20	2,980	25	3,005	32
5-May-2010	16:00	657.33	512.20	2,980	25	3,005	32
5-May-2010	17:00	657.33	512.20	2,980	25	3,005	32
5-May-2010	18:00	657.33	512.10	2,970	25	2,995	32

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Dale Hollow Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Tailwater Elevation ft	Dale Hollow Dam Turbine Discharge cfs	Dale Hollow Dam Gate Release cfs	Dale Hollow Dam Total Discharge cfs	Dale Hollow Dam Gross Energy mwh
5-May-2010	19:00	657.33	512.10	2,970	25	2,995	32
5-May-2010	20:00	657.34	512.10	2,970	25	2,995	32
5-May-2010	21:00	657.34	512.10	2,970	25	2,995	32
5-May-2010	22:00	657.34	512.00	2,960	25	2,985	32
5-May-2010	23:00	657.34	512.00	2,960	25	2,985	32
5-May-2010	24:00:00	657.34	512.00	2,960	25	2,985	32
6-May-2010	1:00	657.31	513.20	3,340	25	3,365	36
6-May-2010	2:00	657.31	513.20	3,340	25	3,365	36
6-May-2010	3:00	657.30	513.30	3,340	25	3,365	36
6-May-2010	4:00	657.30	513.40	3,340	25	3,365	36
6-May-2010	5:00	657.29	513.50	3,340	25	3,365	36
6-May-2010	6:00	657.29	513.50	3,340	25	3,365	36
6-May-2010	7:00	657.28	513.50	3,340	25	3,365	36
6-May-2010	8:00	657.34	512.50	3,300	25	3,325	36
6-May-2010	9:00	657.34	512.60	3,300	25	3,325	36
6-May-2010	10:00	657.34	512.70	3,320	25	3,345	36
6-May-2010	11:00	657.34	512.80	3,320	25	3,345	36
6-May-2010	12:00	657.34	512.90	3,320	25	3,345	36
6-May-2010	13:00	657.34	513.00	3,320	25	3,345	36
6-May-2010	14:00	657.34	513.00	3,320	25	3,345	36
6-May-2010	15:00	657.33	513.00	3,320	25	3,345	36
6-May-2010	16:00	657.33	513.00	3,320	25	3,345	36
6-May-2010	17:00	657.33	513.00	3,320	25	3,345	36
6-May-2010	18:00	657.33	513.00	3,320	25	3,345	36
6-May-2010	19:00	657.32	513.00	3,320	25	3,345	36
6-May-2010	20:00	657.32	513.00	3,320	25	3,345	36
6-May-2010	21:00	657.32	513.00	3,320	25	3,345	36

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Dale Hollow Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	Dale Hollow Dam Headwater Elevation ft	Dale Hollow Dam Tailwater Elevation ft	Dale Hollow Dam Turbine Discharge cfs	Dale Hollow Dam Gate Release cfs	Dale Hollow Dam Total Discharge cfs	Dale Hollow Dam Gross Energy mwh
6-May-2010	22:00	657.32	513.10	3,340	25	3,365	36
6-May-2010	23:00	657.32	513.10	3,340	25	3,365	36
6-May-2010	24:00:00	657.32	513.10	3,340	25	3,365	36
7-May-2010	1:00	657.31	513.20	3,340	25	3,365	36
7-May-2010	2:00	657.31	513.20	3,340	25	3,365	36
7-May-2010	3:00	657.30	513.30	3,340	25	3,365	36
7-May-2010	4:00	657.30	513.40	3,340	25	3,365	36
7-May-2010	5:00	657.29	513.50	3,340	25	3,365	36
7-May-2010	6:00	657.29	513.50	3,340	25	3,365	36

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J. Percy Priest Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Tailwater Elevation ft	J. Percy Priest Dam Turbine Discharge cfs	J. Percy Priest Dam Sluice Gate Release cfs	J. Percy Priest Dam Total Discharge cfs	J. Percy Priest Dam Gross Energy mwh
29-Apr-2010	1:00	489.31	389.11	0	0	0	0
29-Apr-2010	2:00	489.31	389.11	0	0	0	0
29-Apr-2010	3:00	489.32	389.12	0	0	0	0
29-Apr-2010	4:00	489.32	389.22	0	0	0	0
29-Apr-2010	5:00	489.32	389.22	0	0	0	0
29-Apr-2010	6:00	489.32	389.22	0	0	0	0
29-Apr-2010	7:00	489.33	389.23	0	0	0	0
29-Apr-2010	8:00	489.33	389.23	0	0	0	0
29-Apr-2010	9:00	489.33	389.23	0	0	0	0
29-Apr-2010	10:00	489.33	389.23	0	0	0	0
29-Apr-2010	11:00	489.33	389.33	0	0	0	0
29-Apr-2010	12:00	489.33	389.43	0	0	0	0
29-Apr-2010	13:00	489.34	390.04	0	0	0	0
29-Apr-2010	14:00	489.34	390.14	0	0	0	0
29-Apr-2010	15:00	489.34	390.44	0	0	0	0
29-Apr-2010	16:00	489.34	390.44	0	0	0	0
29-Apr-2010	17:00	489.34	390.44	0	0	0	0
29-Apr-2010	18:00	489.34	390.54	0	0	0	0
29-Apr-2010	19:00	489.34	390.64	0	0	0	0
29-Apr-2010	20:00	489.34	390.74	0	0	0	0
29-Apr-2010	21:00	489.34	390.84	0	0	0	0
29-Apr-2010	22:00	489.34	390.84	0	0	0	0
29-Apr-2010	23:00	489.34	390.94	0	0	0	0
29-Apr-2010	24:00:00	489.34	390.94	0	0	0	0
30-Apr-2010	1:00	489.34	391.14	0	0	0	0
30-Apr-2010	2:00	489.34	391.14	0	0	0	0
30-Apr-2010	3:00	489.34	391.14	0	0	0	0

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J. Percy Priest Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Tailwater Elevation ft	J. Percy Priest Dam Turbine Discharge cfs	J. Percy Priest Dam Sluice Gate Release cfs	J. Percy Priest Dam Total Discharge cfs	J. Percy Priest Dam Gross Energy mwh
30-Apr-2010	4:00	489.34	391.24	0	0	0	0
30-Apr-2010	5:00	489.35	391.25	0	0	0	0
30-Apr-2010	6:00	489.35	391.25	0	0	0	0
30-Apr-2010	7:00	489.36	391.26	0	0	0	0
30-Apr-2010	8:00	489.36	391.24	0	0	0	0
30-Apr-2010	9:00	489.36	391.24	0	0	0	0
30-Apr-2010	10:00	489.36	391.36	0	0	0	0
30-Apr-2010	11:00	489.35	390.85	0	0	0	0
30-Apr-2010	12:00	489.35	390.75	0	0	0	0
30-Apr-2010	13:00	489.35	390.75	0	0	0	0
30-Apr-2010	14:00	489.35	390.65	0	0	0	0
30-Apr-2010	15:00	489.35	390.55	0	0	0	0
30-Apr-2010	16:00	489.35	390.45	0	0	0	0
30-Apr-2010	17:00	489.35	390.45	0	0	0	0
30-Apr-2010	18:00	489.35	390.45	0	0	0	0
30-Apr-2010	19:00	489.35	390.15	0	0	0	0
30-Apr-2010	20:00	489.35	390.15	0	0	0	0
30-Apr-2010	21:00	489.35	389.95	0	0	0	0
30-Apr-2010	22:00	489.35	389.85	0	0	0	0
30-Apr-2010	23:00	489.35	389.75	0	0	0	0
30-Apr-2010	24:00:00	489.35	389.75	0	0	0	0
1-May-2010	1:00	489.36	389.66	0	0	0	0
1-May-2010	2:00	489.36	389.96	0	0	0	0
1-May-2010	3:00	489.36	390.16	0	0	0	0
1-May-2010	4:00	489.36	390.26	0	0	0	0
1-May-2010	5:00	489.36	390.26	0	0	0	0
1-May-2010	6:00	489.36	390.26	0	0	0	0

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J. Percy Priest Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Tailwater Elevation ft	J. Percy Priest Dam Turbine Discharge cfs	J. Percy Priest Dam Sluice Gate Release cfs	J. Percy Priest Dam Total Discharge cfs	J. Percy Priest Dam Gross Energy mwh
1-May-2010	7:00	489.37	390.57	0	0	0	0
1-May-2010	8:00	489.40	390.50	0	0	0	0
1-May-2010	9:00	489.45	391.25	0	0	0	0
1-May-2010	10:00	489.47	391.37	0	0	0	0
1-May-2010	11:00	489.48	395.48	4,600	0	4,600	30
1-May-2010	12:00	489.50	396.20	4,600	0	4,600	30
1-May-2010	13:00	489.60	396.90	4,600	0	4,600	30
1-May-2010	14:00	489.68	397.58	4,600	0	4,600	30
1-May-2010	15:00	489.84	399.24	4,600	0	4,600	30
1-May-2010	16:00	490.00	400.00	4,700	0	4,700	30
1-May-2010	17:00	490.30	402.00	4,700	0	4,700	30
1-May-2010	18:00	490.45	402.85	4,700	0	4,700	30
1-May-2010	19:00	490.95	404.25	4,800	0	4,800	30
1-May-2010	20:00	491.43	405.43	4,800	0	4,800	30
1-May-2010	21:00	491.93	406.23	4,800	0	4,800	30
1-May-2010	22:00	492.43	407.13	4,800	0	4,800	30
1-May-2010	23:00	492.95	407.55	4,800	0	4,800	30
1-May-2010	24:00:00	493.55	408.05	4,800	0	4,800	30
2-May-2010	1:00	494.68	409.08	4,800	0	4,800	30
2-May-2010	2:00	494.97	409.77	4,800	0	4,800	30
2-May-2010	3:00	495.26	410.46	4,800	0	4,800	30
2-May-2010	4:00	495.49	410.69	4,800	0	4,800	30
2-May-2010	5:00	495.71	410.61	4,800	0	4,800	30
2-May-2010	6:00	495.91	410.61	4,800	0	4,800	30
2-May-2010	7:00	496.11	411.11	4,800	0	4,800	30
2-May-2010	8:00	496.25	411.35	4,800	0	4,800	30
2-May-2010	9:00	496.40	413.30	4,900	0	4,900	30

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J. Percy Priest Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Tailwater Elevation ft	J. Percy Priest Dam Turbine Discharge cfs	J. Percy Priest Dam Sluice Gate Release cfs	J. Percy Priest Dam Total Discharge cfs	J. Percy Priest Dam Gross Energy mwh
2-May-2010	10:00	496.67	414.86	4,900	0	4,900	30
2-May-2010	11:00	496.87	416.17	4,900	0	4,900	30
2-May-2010	12:00	497.07	417.57	5,000	0	5,000	30
2-May-2010	13:00	497.10	418.30	5,000	0	5,000	30
2-May-2010	14:00	497.30	418.30	5,000	0	5,000	30
2-May-2010	15:00	497.47	418.57	5,000	0	5,000	30
2-May-2010	16:00	497.70	419.90	5,000	0	5,000	30
2-May-2010	17:00	497.80	420.70	5,000	0	5,000	30
2-May-2010	18:00	497.95	421.65	5,000	0	5,000	30
2-May-2010	19:00	498.05	422.25	5,200	0	5,200	30
2-May-2010	20:00	498.17	422.97	5,200	0	5,200	30
2-May-2010	21:00	498.29	423.49	5,200	0	5,200	30
2-May-2010	22:00	498.46	424.16	0	0	0	0
2-May-2010	23:00	498.61	424.61	0	0	0	0
2-May-2010	24:00:00	498.71	424.71	0	0	0	0
3-May-2010	1:00	498.98	424.40	0	0	0	0
3-May-2010	2:00	499.06	424.96	0	0	0	0
3-May-2010	3:00	499.22	424.82	0	0	0	0
3-May-2010	4:00	499.36	424.56	0	0	0	0
3-May-2010	5:00	499.48	424.48	0	0	0	0
3-May-2010	6:00	499.56	424.56	0	0	0	0
3-May-2010	7:00	499.72	424.82	0	0	0	0
3-May-2010	8:00	502.00	424.50	3,900	0	3,900	18
3-May-2010	9:00	502.25	424.95	5,100	0	5,100	27
3-May-2010	10:00	502.50	427.60	5,200	0	5,200	30
3-May-2010	11:00	502.60	427.90	5,200	0	5,200	30
3-May-2010	12:00	502.60	427.90	5,200	0	5,200	30

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J. Percy Priest Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Tailwater Elevation ft	J. Percy Priest Dam Turbine Discharge cfs	J. Percy Priest Dam Sluice Gate Release cfs	J. Percy Priest Dam Total Discharge cfs	J. Percy Priest Dam Gross Energy mwh
3-May-2010	13:00	502.80	428.10	5,200	0	5,200	30
3-May-2010	14:00	503.00	428.25	5,200	0	5,200	30
3-May-2010	15:00	503.30	428.30	5,200	0	5,200	30
3-May-2010	16:00	503.50	428.10	5,200	0	5,200	30
3-May-2010	17:00	503.80	428.00	5,200	0	5,200	30
3-May-2010	18:00	504.01	427.81	5,200	0	5,200	30
3-May-2010	19:00	504.20	427.40	5,100	0	5,100	30
3-May-2010	20:00	504.18	427.28	5,100	0	5,100	30
3-May-2010	21:00	504.25	426.85	5,100	0	5,100	30
3-May-2010	22:00	504.30	426.60	5,100	0	5,100	30
3-May-2010	23:00	504.35	426.45	5,000	0	5,000	30
3-May-2010	24:00:00	504.35	426.25	5,000	1,000	6,000	30
4-May-2010	1:00	504.40	426.10	5,000	2,000	7,000	30
4-May-2010	2:00	504.40	425.90	5,000	2,000	7,000	30
4-May-2010	3:00	504.40	425.80	5,000	2,000	7,000	30
4-May-2010	4:00	504.40	425.70	5,000	2,000	7,000	30
4-May-2010	5:00	504.42	425.52	5,000	2,000	7,000	30
4-May-2010	6:00	504.42	425.52	5,000	2,000	7,000	30
4-May-2010	7:00	504.54	425.34	5,000	2,000	7,000	30
4-May-2010	8:00	504.60	425.30	5,000	2,000	7,000	30
4-May-2010	9:00	504.90	425.20	5,000	3,600	8,600	30
4-May-2010	10:00	504.90	425.20	5,000	3,600	8,600	30
4-May-2010	11:00	504.90	425.10	5,000	3,600	8,600	30
4-May-2010	12:00	504.90	425.10	5,000	3,600	8,600	30
4-May-2010	13:00	504.90	425.10	5,000	3,600	8,600	30
4-May-2010	14:00	504.90	425.00	5,000	3,600	8,600	30
4-May-2010	15:00	504.90	425.00	5,000	3,600	8,600	30

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J. Percy Priest Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Tailwater Elevation ft	J. Percy Priest Dam Turbine Discharge cfs	J. Percy Priest Dam Sluice Gate Release cfs	J. Percy Priest Dam Total Discharge cfs	J. Percy Priest Dam Gross Energy mwh
4-May-2010	16:00	504.90	425.00	5,000	3,600	8,600	30
4-May-2010	17:00	504.90	424.90	5,000	3,600	8,600	30
4-May-2010	18:00	504.90	424.90	5,000	3,600	8,600	30
4-May-2010	19:00	504.85	424.85	4,900	3,700	8,600	30
4-May-2010	20:00	504.80	424.90	4,900	3,700	8,600	30
4-May-2010	21:00	504.68	424.78	4,900	3,700	8,600	30
4-May-2010	22:00	504.55	424.65	4,900	3,700	8,600	30
4-May-2010	23:00	504.48	424.58	4,900	3,700	8,600	30
4-May-2010	24:00:00	504.40	424.50	4,900	3,700	8,600	30
5-May-2010	1:00	504.40	424.50	4,900	3,700	8,600	30
5-May-2010	2:00	504.40	424.50	4,900	3,700	8,600	30
5-May-2010	3:00	504.40	424.40	4,900	3,700	8,600	30
5-May-2010	4:00	504.40	424.30	4,900	3,700	8,600	30
5-May-2010	5:00	504.39	424.19	4,900	3,700	8,600	30
5-May-2010	6:00	504.39	424.19	4,900	3,700	8,600	30
5-May-2010	7:00	504.70	424.20	4,900	3,700	8,600	30
5-May-2010	8:00	504.62	424.50	4,900	3,700	8,600	30
5-May-2010	9:00	504.61	424.11	4,900	3,700	8,600	30
5-May-2010	10:00	504.60	424.00	4,900	3,700	8,600	30
5-May-2010	11:00	504.59	423.89	4,900	3,700	8,600	30
5-May-2010	12:00	504.58	423.88	4,900	3,700	8,600	30
5-May-2010	13:00	504.57	423.87	4,900	3,700	8,600	30
5-May-2010	14:00	504.56	423.76	4,900	3,700	8,600	30
5-May-2010	15:00	504.55	423.55	4,900	3,700	8,600	30
5-May-2010	16:00	504.55	423.35	4,900	3,700	8,600	30
5-May-2010	17:00	504.55	423.05	4,900	3,700	8,600	30
5-May-2010	18:00	504.55	423.05	4,900	3,700	8,600	30

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J. Percy Priest Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Tailwater Elevation ft	J. Percy Priest Dam Turbine Discharge cfs	J. Percy Priest Dam Sluice Gate Release cfs	J. Percy Priest Dam Total Discharge cfs	J. Percy Priest Dam Gross Energy mwh
5-May-2010	19:00	504.60	422.40	4,900	3,700	8,600	30
5-May-2010	20:00	504.60	422.00	4,900	3,700	8,600	30
5-May-2010	21:00	504.59	421.69	4,900	3,700	8,600	30
5-May-2010	22:00	504.58	421.28	4,800	3,700	8,500	30
5-May-2010	23:00	504.57	420.97	4,800	3,700	8,500	30
5-May-2010	24:00:00	504.56	420.46	4,800	3,700	8,500	30
6-May-2010	1:00	504.55	420.05	4,800	3,700	8,500	30
6-May-2010	2:00	504.54	419.64	4,800	3,700	8,500	30
6-May-2010	3:00	504.53	419.03	4,800	3,700	8,500	30
6-May-2010	4:00	504.52	418.42	4,800	3,700	8,500	30
6-May-2010	5:00	504.50	417.80	4,800	3,700	8,500	30
6-May-2010	6:00	504.49	417.29	4,800	3,700	8,500	30
6-May-2010	7:00	504.29	416.39	4,700	3,700	8,400	30
6-May-2010	8:00	504.28	415.78	4,700	3,700	8,400	30
6-May-2010	9:00	504.26	415.36	4,700	3,700	8,400	30
6-May-2010	10:00	504.25	414.85	4,700	3,700	8,400	30
6-May-2010	11:00	504.24	414.34	4,700	3,700	8,400	30
6-May-2010	12:00	504.23	413.93	4,700	3,700	8,400	30
6-May-2010	13:00	504.22	413.52	4,600	3,700	8,300	30
6-May-2010	14:00	504.21	412.01	4,600	3,700	8,300	30
6-May-2010	15:00	504.20	412.50	4,600	3,700	8,300	30
6-May-2010	16:00	504.19	411.99	4,600	3,700	8,300	30
6-May-2010	17:00	504.17	411.47	4,600	3,700	8,300	30
6-May-2010	18:00	504.16	411.36	4,600	3,700	8,300	30
6-May-2010	19:00	504.00	410.70	4,600	3,700	8,300	30
6-May-2010	20:00	503.98	410.49	4,600	3,700	8,300	30
6-May-2010	21:00	503.98	410.18	4,600	3,700	8,300	30

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J. Percy Priest Dam Hourly Water Control Data -> 29 April - 07 May 2010							
Date	Time	J. Percy Priest Dam Headwater Elevation ft	J. Percy Priest Dam Tailwater Elevation ft	J. Percy Priest Dam Turbine Discharge cfs	J. Percy Priest Dam Sluice Gate Release cfs	J. Percy Priest Dam Total Discharge cfs	J. Percy Priest Dam Gross Energy mwh
6-May-2010	22:00	503.97	409.87	4,600	3,700	8,300	30
6-May-2010	23:00	503.95	409.65	4,600	3,700	8,300	30
6-May-2010	24:00:00	503.92	409.32	4,600	3,700	8,300	30
7-May-2010	1:00	503.90	409.20	4,600	3,700	8,300	30
7-May-2010	2:00	503.89	408.99	4,600	3,700	8,300	30
7-May-2010	3:00	503.88	408.78	4,600	3,700	8,300	30
7-May-2010	4:00	503.87	408.67	4,600	3,700	8,300	30
7-May-2010	5:00	503.82	408.42	4,500	3,700	8,200	30
7-May-2010	6:00	503.77	408.17	4,500	3,700	8,200	30

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Damage Center Tables

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Cumberland River Damage Centers Hourly Water Control Data -> 29 April - 07 May 2010												
Date	Time	Celina Stage ft	Celina Elevation ft	Celina Flow cfs	Carthage Stage ft	Carthage Elevation ft	Carthage Flow cfs	Nashville Stage ft	Nashville Elevation ft	Nashville Flow cfs	Clarksville Stage ft	Clarksville Elevation ft
29-Apr-2010	1:00	18.21	507.21	17,187	11.59	449.12	16,531	18.50	386.61	18,438	61.38	361.38
29-Apr-2010	2:00	18.41	507.41	18,278	11.63	449.16	16,656	18.50	386.61	17,918	61.15	361.15
29-Apr-2010	3:00	18.09	507.09	16,548	11.73	449.26	16,969	18.51	386.62	17,430	60.99	360.99
29-Apr-2010	4:00	18.08	507.08	16,495	11.81	449.34	17,219	18.59	386.70	17,839	60.89	360.89
29-Apr-2010	5:00	18.10	507.10	16,601	11.85	449.38	17,344	18.66	386.77	17,793	60.83	360.83
29-Apr-2010	6:00	18.18	507.18	16,994	11.82	449.35	17,250	18.75	386.86	17,945	60.79	360.79
29-Apr-2010	7:00	18.20	507.20	17,068	11.80	449.33	17,188	18.81	386.92	17,374	60.77	360.77
29-Apr-2010	8:00	18.24	507.24	17,184	11.78	449.31	17,125	18.88	386.99	17,536	60.83	360.83
29-Apr-2010	9:00	18.28	507.28	16,441	11.75	449.28	17,031	18.95	387.06	18,735	60.74	360.74
29-Apr-2010	10:00	18.31	507.31	17,463	11.75	449.28	17,031	19.03	387.14	19,419	61.04	361.04
29-Apr-2010	11:00	18.35	507.35	17,714	11.70	449.23	16,922	19.05	387.16	19,087	61.15	361.15
29-Apr-2010	12:00	18.38	507.38	17,744	11.55	449.08	16,454	19.02	387.13	19,327	61.20	361.20
29-Apr-2010	13:00	18.41	507.41	17,875	11.57	449.10	16,564	19.08	387.19	19,985	61.24	361.24
29-Apr-2010	14:00	18.44	507.44	17,973	11.62	449.15	16,719	19.19	387.30	20,909	61.24	361.24
29-Apr-2010	15:00	18.47	507.47	18,138	11.70	449.23	16,969	19.27	387.38	21,387	61.23	361.23
29-Apr-2010	16:00	18.50	507.50	18,304	11.78	449.31	17,219	19.37	387.48	21,964	61.27	361.27
29-Apr-2010	17:00	18.51	507.51	18,326	11.83	449.36	17,423	19.40	387.51	21,548	61.24	361.24
29-Apr-2010	18:00	18.52	507.52	18,348	11.80	449.33	17,329	19.46	387.57	22,251	61.27	361.27
29-Apr-2010	19:00	18.52	507.52	18,314	12.60	450.13	19,880	19.50	387.61	22,175	61.23	361.23
29-Apr-2010	20:00	18.51	507.51	18,292	13.09	450.62	21,569	19.55	387.66	22,386	61.22	361.22
29-Apr-2010	21:00	18.50	507.50	18,304	13.40	450.93	22,656	19.58	387.69	22,045	61.25	361.25
29-Apr-2010	22:00	18.50	507.50	18,678	12.99	450.52	21,264	19.68	387.79	23,087	61.27	361.27
29-Apr-2010	23:00	18.46	507.46	18,624	12.68	450.21	20,215	19.73	387.84	22,935	61.29	361.29
29-Apr-2010	24:00:00	18.42	507.42	18,502	12.48	450.01	19,621	19.77	387.88	23,022	61.31	361.31
30-Apr-2010	1:00	18.38	507.38	18,113	12.39	449.92	19,341	19.83	387.94	23,157	61.34	361.34

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Cumberland River Damage Centers Hourly Water Control Data -> 29 April - 07 May 2010												
Date	Time	Celina Stage ft	Celina Elevation ft	Celina Flow cfs	Carthage Stage ft	Carthage Elevation ft	Carthage Flow cfs	Nashville Stage ft	Nashville Elevation ft	Nashville Flow cfs	Clarksville Stage ft	Clarksville Elevation ft
30-Apr-2010	2:00	18.36	507.36	17,969	12.32	449.85	19,112	19.91	388.02	23,436	61.36	361.36
30-Apr-2010	3:00	18.36	507.36	18,003	12.30	449.83	19,059	19.93	388.04	22,899	61.33	361.33
30-Apr-2010	4:00	18.37	507.37	18,058	12.19	449.72	18,714	19.98	388.09	23,297	61.30	361.30
30-Apr-2010	5:00	18.36	507.36	17,969	12.08	449.61	18,378	20.03	388.14	23,346	61.27	361.27
30-Apr-2010	6:00	18.37	507.37	17,957	12.00	449.53	18,156	20.08	388.19	23,436	61.26	361.26
30-Apr-2010	7:00	18.38	507.38	18,012	11.93	449.46	17,974	20.08	388.19	22,929	61.26	361.26
30-Apr-2010	8:00	18.79	507.79	19,920	11.76	449.29	17,440	20.14	388.25	23,462	61.25	361.25
30-Apr-2010	9:00	18.43	507.43	18,255	11.68	449.21	17,236	20.17	388.28	22,982	61.24	361.24
30-Apr-2010	10:00	18.82	507.82	19,988	11.52	449.05	16,747	20.21	388.32	22,986	61.24	361.24
30-Apr-2010	11:00	18.50	507.50	18,508	11.35	448.88	16,242	20.23	388.34	22,892	61.23	361.23
30-Apr-2010	12:00	18.81	507.81	19,895	11.31	448.84	16,175	20.17	388.28	22,520	61.22	361.22
30-Apr-2010	13:00	18.55	507.55	18,687	11.18	448.71	15,792	20.10	388.21	22,904	61.19	361.19
30-Apr-2010	14:00	18.53	507.53	18,506	11.91	449.44	18,054	20.07	388.18	23,073	61.40	361.40
30-Apr-2010	15:00	18.55	507.55	18,618	12.38	449.91	19,484	20.00	388.11	23,190	61.47	361.47
30-Apr-2010	16:00	18.89	507.89	20,202	12.74	450.27	20,612	19.87	387.98	22,697	61.55	361.55
30-Apr-2010	17:00	18.63	507.63	18,381	12.98	450.51	21,452	19.76	387.87	22,631	61.62	361.62
30-Apr-2010	18:00	18.58	507.58	19,113	13.41	450.94	22,875	19.68	387.79	22,558	61.63	361.63
30-Apr-2010	19:00	18.52	507.52	19,012	13.72	451.25	23,862	19.55	387.66	22,543	61.65	361.65
30-Apr-2010	20:00	18.50	507.50	19,035	14.02	451.55	24,750	19.44	387.55	22,628	61.67	361.67
30-Apr-2010	21:00	18.47	507.47	18,984	14.28	451.81	25,555	19.33	387.44	22,492	61.67	361.67
30-Apr-2010	22:00	18.43	507.43	18,911	13.73	451.26	23,819	19.24	387.35	22,606	61.67	361.67
30-Apr-2010	23:00	18.47	507.47	19,170	13.34	450.87	22,579	19.12	387.23	22,366	61.68	361.68
30-Apr-2010	24:00:00	18.59	507.59	19,719	13.06	450.59	21,638	19.01	387.12	22,428	61.68	361.68
1-May-2010	1:00	18.37	507.37	18,743	12.88	450.41	21,034	18.92	387.03	22,480	61.67	361.67
1-May-2010	2:00	18.34	507.34	18,593	12.73	450.26	20,522	18.80	386.91	22,339	61.66	361.66

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Cumberland River Damage Centers Hourly Water Control Data -> 29 April - 07 May 2010												
Date	Time	Celina Stage ft	Celina Elevation ft	Celina Flow cfs	Carthage Stage ft	Carthage Elevation ft	Carthage Flow cfs	Nashville Stage ft	Nashville Elevation ft	Nashville Flow cfs	Clarksville Stage ft	Clarksville Elevation ft
1-May-2010	3:00	18.37	507.37	18,726	12.60	450.13	20,072	18.81	386.92	23,233	61.64	361.64
1-May-2010	4:00	18.37	507.37	18,710	12.48	450.01	19,708	18.82	386.93	23,742	61.62	361.62
1-May-2010	5:00	18.38	507.38	18,715	12.35	449.88	19,303	18.81	386.92	24,204	61.70	361.70
1-May-2010	6:00	18.38	507.38	18,699	12.39	449.92	19,467	18.83	386.94	24,230	61.74	361.74
1-May-2010	7:00	18.39	507.39	19,475	12.30	449.83	19,155	18.84	386.95	24,413	61.76	361.76
1-May-2010	8:00	18.41	507.41	18,547	12.24	449.77	18,909	19.27	387.38	28,204	61.87	361.87
1-May-2010	9:00	18.48	507.48	18,905	12.18	449.71	18,711	19.48	387.59	27,370	61.98	361.98
1-May-2010	10:00	18.52	507.52	19,012	12.11	449.64	18,463	19.79	387.90	27,853	62.03	362.03
1-May-2010	11:00	18.57	507.57	19,142	12.69	450.22	20,218	20.27	388.38	29,480	62.20	362.20
1-May-2010	12:00	18.62	507.62	19,306	13.17	450.70	21,810	20.79	388.90	30,211	62.40	362.40
1-May-2010	13:00	18.71	507.71	19,615	13.64	451.17	23,344	21.52	389.63	33,349	62.79	362.79
1-May-2010	14:00	18.88	507.88	20,339	13.94	451.47	24,294	22.29	390.40	37,910	63.68	363.68
1-May-2010	15:00	19.02	508.02	20,771	14.41	451.94	25,695	23.58	391.69	46,136	64.93	364.93
1-May-2010	16:00	19.36	508.36	21,348	15.90	453.43	30,357	25.11	393.22	54,909	66.47	366.47
1-May-2010	17:00	20.40	509.40	24,128	18.26	455.79	38,071	26.61	394.72	63,030	67.98	367.98
1-May-2010	18:00	21.82	510.82	26,654	20.70	458.23	60,354	28.04	396.15	70,284	69.48	369.48
1-May-2010	19:00	22.83	511.83	29,052	22.93	460.46	69,717	29.38	397.49	78,304	70.97	370.97
1-May-2010	20:00	23.84	512.84	31,461	25.06	462.59	78,796	30.69	398.80	85,786	72.52	372.52
1-May-2010	21:00	24.72	513.72	33,611	26.57	464.10	83,742	31.61	399.72	89,298	73.64	373.64
1-May-2010	22:00	25.42	514.42	35,325	27.70	465.23	88,207	32.00	400.11	84,093	74.41	374.41
1-May-2010	23:00	26.06	515.06	36,894	28.60	466.13	92,064	33.45	401.56	99,653	75.20	375.20
1-May-2010	24:00:00	26.22	515.22	37,284	29.59	467.12	95,666	34.52	402.63	100,646	75.81	375.81
2-May-2010	1:00	26.54	515.54	38,066	30.63	468.16	99,521	35.15	403.26	103,546	76.85	376.85
2-May-2010	2:00	26.82	515.82	38,749	31.29	468.82	96,766	35.90	404.01	114,066	77.48	377.48
2-May-2010	3:00	26.99	515.99	39,164	31.66	469.19	89,718	36.51	404.62	115,400	78.04	378.04

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Cumberland River Damage Centers Hourly Water Control Data -> 29 April - 07 May 2010												
Date	Time	Celina Stage ft	Celina Elevation ft	Celina Flow cfs	Carthage Stage ft	Carthage Elevation ft	Carthage Flow cfs	Nashville Stage ft	Nashville Elevation ft	Nashville Flow cfs	Clarksville Stage ft	Clarksville Elevation ft
2-May-2010	4:00	27.11	516.11	39,460	31.94	469.47	88,019	36.91	405.02	110,548	78.44	378.44
2-May-2010	5:00	27.17	516.17	39,608	32.18	469.71	87,584	37.17	405.28	106,979	78.83	378.83
2-May-2010	6:00	27.17	516.17	39,608	32.36	469.89	86,346	37.33	405.44	104,309	79.27	379.27
2-May-2010	7:00	27.13	516.13	39,509	32.45	469.98	83,931	37.43	405.54	102,633	79.74	379.74
2-May-2010	8:00	27.06	516.06	39,337	32.56	470.09	84,845	37.79	405.90	112,177	80.15	380.15
2-May-2010	9:00	27.13	516.13	39,509	32.65	470.18	84,505	38.93	407.04	126,650	80.51	380.51
2-May-2010	10:00	26.91	515.91	38,969	32.66	470.19	81,833	40.33	408.44	133,800	80.91	380.91
2-May-2010	11:00	26.99	515.99	39,164	32.62	470.15	80,251	41.50	409.61	140,182	81.29	381.29
2-May-2010	12:00	27.19	516.19	39,657	32.62	470.15	81,722	42.61	410.72	146,460	81.73	381.73
2-May-2010	13:00	27.47	516.47	40,347	32.59	470.12	81,639	43.72	411.83	153,467	82.19	382.19
2-May-2010	14:00	27.48	516.48	40,372	32.54	470.07	79,666	44.24	412.35	152,487	82.67	382.67
2-May-2010	15:00	27.76	516.76	41,061	32.83	470.36	91,057	45.14	413.25	163,050	83.05	383.05
2-May-2010	16:00	28.29	517.29	42,380	33.26	470.79	96,665	45.64	413.75	161,240	83.64	383.64
2-May-2010	17:00	29.40	518.40	45,165	34.24	471.77	113,271	46.34	414.45	171,240	84.16	384.16
2-May-2010	18:00	31.50	520.50	50,434	35.18	472.71	117,376	46.86	414.97	169,570	84.67	384.67
2-May-2010	19:00	33.38	522.38	55,207	35.89	473.42	115,909	47.44	415.55	177,092	85.19	385.19
2-May-2010	20:00	34.66	523.66	58,655	36.78	474.31	124,363	47.87	415.98	173,484	85.64	385.64
2-May-2010	21:00	35.50	524.50	60,917	37.44	474.97	121,302	48.33	416.44	178,155	86.17	386.17
2-May-2010	22:00	36.01	525.01	62,288	38.15	475.68	126,761	48.88	416.99	186,384	86.58	386.58
2-May-2010	23:00	36.41	525.41	63,363	38.89	476.42	131,485	49.31	417.42	183,949	87.03	387.03
2-May-2010	24:00:00	36.59	525.59	63,847	39.67	477.20	139,166	49.63	417.74	185,569	87.50	387.50
3-May-2010	1:00	36.90	525.90	64,680	40.50	478.03	142,790	50.04	418.15	188,644	87.95	387.95
3-May-2010	2:00	37.14	526.14	65,325	41.28	478.81	143,518	50.12	418.23	171,542	88.35	388.35
3-May-2010	3:00	37.38	526.38	65,970	42.23	479.76	150,344	50.43	418.54	186,034	88.74	388.74
3-May-2010	4:00	37.51	526.51	66,320	42.91	480.44	146,849	50.50	418.61	173,406	89.14	389.14

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Cumberland River Damage Centers Hourly Water Control Data -> 29 April - 07 May 2010												
Date	Time	Celina Stage ft	Celina Elevation ft	Celina Flow cfs	Carthage Stage ft	Carthage Elevation ft	Carthage Flow cfs	Nashville Stage ft	Nashville Elevation ft	Nashville Flow cfs	Clarksville Stage ft	Clarksville Elevation ft
3-May-2010	5:00	37.58	526.58	66,508	43.45	480.98	143,510	50.62	418.73	177,075	89.49	389.49
3-May-2010	6:00	37.62	526.62	66,615	44.23	481.76	157,931	50.56	418.67	166,084	89.83	389.83
3-May-2010	7:00	37.60	526.60	66,562	44.68	482.21	145,087	50.74	418.85	181,505	90.10	390.10
3-May-2010	8:00	37.58	526.58	66,508	45.17	482.70	149,277	50.79	418.90	174,500	90.48	390.48
3-May-2010	9:00	37.37	526.37	65,943	45.42	482.95	139,278	50.87	418.98	176,935	90.67	390.67
3-May-2010	10:00	37.15	526.15	65,352	45.82	483.35	148,207	51.05	419.16	184,244	90.99	390.99
3-May-2010	11:00	36.97	525.97	64,868	46.02	483.55	139,641	51.13	419.24	179,161	91.28	391.28
3-May-2010	12:00	36.69	525.69	64,116	46.06	483.59	132,211	51.19	419.30	178,485	91.60	391.60
3-May-2010	13:00	36.36	525.36	63,228	45.96	483.49	123,991	51.49	419.60	194,425	91.70	391.70
3-May-2010	14:00	36.06	525.06	62,422	46.00	483.53	131,907	51.38	419.49	169,340	91.86	391.86
3-May-2010	15:00	35.83	524.83	61,804	45.97	483.50	129,875	51.71	419.82	197,865	92.14	392.14
3-May-2010	16:00	35.34	524.34	60,487	46.00	483.53	130,000	51.81	419.92	185,455	92.32	392.32
3-May-2010	17:00	35.02	524.02	59,627	45.76	483.29	114,810	51.85	419.96	179,643	92.48	392.48
3-May-2010	18:00	34.61	523.61	58,520	45.63	483.16	120,944	51.86	419.97	179,714	92.61	392.61
3-May-2010	19:00	34.01	523.01	56,901	45.34	482.87	110,071	51.83	419.94	179,500	92.76	392.76
3-May-2010	20:00	33.68	522.68	56,013	45.06	482.59	109,693	51.72	419.83	171,673	92.72	392.72
3-May-2010	21:00	33.12	522.12	54,508	44.72	482.25	104,742	51.68	419.79	175,859	92.56	392.56
3-May-2010	22:00	32.65	521.65	53,317	44.39	481.92	104,292	51.44	419.55	161,799	92.44	392.44
3-May-2010	23:00	31.87	520.87	51,362	44.02	481.55	100,650	51.43	419.54	176,643	92.75	392.75
3-May-2010	24:00:00	31.48	520.48	50,383	43.67	481.20	93,266	51.27	419.38	160,688	93.07	393.07
4-May-2010	1:00	30.94	519.94	49,029	43.22	480.75	91,858	51.03	419.14	158,933	93.25	393.25
4-May-2010	2:00	30.06	519.06	46,821	42.68	480.21	80,676	50.96	419.07	168,640	93.29	393.29
4-May-2010	3:00	29.48	518.48	45,366	42.16	479.69	81,319	50.82	418.93	163,310	93.22	393.22
4-May-2010	4:00	28.88	517.88	43,861	41.50	479.03	65,544	50.65	418.76	160,226	93.25	393.25
4-May-2010	5:00	28.24	517.24	42,255	41.08	478.61	88,747	50.57	418.68	164,922	93.42	393.42

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Cumberland River Damage Centers Hourly Water Control Data -> 29 April - 07 May 2010												
Date	Time	Celina Stage ft	Celina Elevation ft	Celina Flow cfs	Carthage Stage ft	Carthage Elevation ft	Carthage Flow cfs	Nashville Stage ft	Nashville Elevation ft	Nashville Flow cfs	Clarksville Stage ft	Clarksville Elevation ft
4-May-2010	6:00	27.65	516.65	40,790	40.56	478.09	77,532	50.47	418.58	163,097	93.38	393.38
4-May-2010	7:00	27.06	516.06	39,337	39.96	477.49	68,393	50.44	418.55	169,000	93.48	393.48
4-May-2010	8:00	26.49	515.49	37,944	39.56	477.09	85,752	50.20	418.31	153,363	93.42	393.42
4-May-2010	9:00	25.91	514.91	36,526	39.12	476.65	81,568	50.26	418.37	171,300	93.31	393.31
4-May-2010	10:00	25.36	514.36	35,177	38.78	476.31	86,520	50.14	418.25	159,972	93.38	393.38
4-May-2010	11:00	24.81	513.81	33,830	38.38	475.91	82,184	49.99	418.10	157,380	93.41	393.41
4-May-2010	12:00	24.34	513.34	32,683	38.06	475.59	85,196	50.02	418.13	166,375	93.40	393.40
4-May-2010	13:00	24.24	513.24	32,439	37.72	475.25	83,020	49.95	418.06	161,756	93.29	393.29
4-May-2010	14:00	23.44	512.44	32,154	37.35	474.88	80,265	49.83	417.94	158,118	93.27	393.27
4-May-2010	15:00	23.33	512.33	30,234	37.08	474.61	84,146	49.76	417.87	160,563	93.19	393.19
4-May-2010	16:00	22.81	511.81	30,766	36.78	474.31	81,643	49.68	417.79	159,416	93.20	393.20
4-May-2010	17:00	22.44	511.44	29,809	36.35	473.88	73,958	49.68	417.79	164,143	93.18	393.18
4-May-2010	18:00	21.67	510.67	26,885	35.76	473.29	59,222	49.49	417.60	151,944	93.07	393.07
4-May-2010	19:00	21.47	510.47	26,746	35.10	472.63	52,124	49.43	417.54	158,850	92.96	392.96
4-May-2010	20:00	20.87	509.87	24,715	34.58	472.11	62,196	49.27	417.38	152,122	92.80	392.80
4-May-2010	21:00	20.51	509.51	23,746	33.89	471.42	47,434	49.34	417.45	165,563	92.39	392.39
4-May-2010	22:00	20.40	509.40	23,837	33.30	470.83	54,096	49.31	417.42	161,500	92.02	392.02
4-May-2010	23:00	19.87	508.87	22,106	32.52	470.05	38,598	49.27	417.38	158,893	92.04	392.04
4-May-2010	24:00:00	19.61	508.61	21,498	31.63	469.16	43,882	49.14	417.25	160,286	92.48	392.48
5-May-2010	1:00	19.57	508.57	21,810	30.94	468.47	42,753	49.16	417.27	160,429	92.45	392.45
5-May-2010	2:00	19.03	508.03	19,819	30.34	467.87	47,925	49.05	417.16	153,396	92.35	392.35
5-May-2010	3:00	19.11	508.11	20,559	29.68	467.21	42,756	48.98	417.09	155,237	92.22	392.22
5-May-2010	4:00	18.67	507.67	18,986	28.98	466.51	39,016	48.92	417.03	155,443	92.14	392.14
5-May-2010	5:00	18.42	507.42	18,199	28.32	465.85	40,493	48.88	416.99	158,625	92.05	392.05
5-May-2010	6:00	18.42	507.42	18,704	27.68	465.21	40,477	48.75	416.86	150,522	91.92	391.92

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Cumberland River Damage Centers Hourly Water Control Data -> 29 April - 07 May 2010												
Date	Time	Celina Stage ft	Celina Elevation ft	Celina Flow cfs	Carthage Stage ft	Carthage Elevation ft	Carthage Flow cfs	Nashville Stage ft	Nashville Elevation ft	Nashville Flow cfs	Clarksville Stage ft	Clarksville Elevation ft
5-May-2010	7:00	18.31	507.31	18,509	27.10	464.63	42,859	48.69	416.80	154,037	91.79	391.79
5-May-2010	8:00	18.06	507.06	17,678	26.60	464.13	46,592	48.65	416.76	157,188	91.67	391.67
5-May-2010	9:00	18.04	507.04	17,891	26.14	463.67	48,017	48.57	416.68	152,175	91.57	391.57
5-May-2010	10:00	17.87	506.87	17,484	25.69	463.22	47,713	48.44	416.55	148,674	91.46	391.46
5-May-2010	11:00	17.69	506.69	16,964	25.83	463.36	65,262	48.43	416.54	155,812	91.34	391.34
5-May-2010	12:00	17.55	506.55	16,628	25.76	463.29	59,950	48.48	416.59	158,779	91.20	391.20
5-May-2010	13:00	17.54	506.54	16,832	25.48	463.01	53,244	48.41	416.52	151,764	91.10	391.10
5-May-2010	14:00	17.53	506.53	17,066	23.24	460.77	22,217	48.30	416.41	148,893	90.94	390.94
5-May-2010	15:00	17.48	506.48	17,119	21.75	459.28	20,215	48.22	416.33	150,051	90.81	390.81
5-May-2010	16:00	17.75	506.75	18,334	20.78	458.31	19,006	47.96	416.07	138,872	90.70	390.70
5-May-2010	17:00	17.44	506.44	16,791	19.48	457.01	42,429	47.97	416.08	152,938	90.55	390.55
5-May-2010	18:00	17.28	506.28	16,131	18.60	456.13	39,286	47.63	415.74	132,534	90.47	390.47
5-May-2010	19:00	17.31	506.31	16,284	17.93	455.46	36,969	47.52	415.63	144,210	90.32	390.32
5-May-2010	20:00	17.43	506.43	16,650	17.34	454.87	35,125	47.28	415.39	135,901	90.14	390.14
5-May-2010	21:00	17.37	506.37	16,327	16.86	454.39	33,625	46.99	415.10	131,370	89.87	389.87
5-May-2010	22:00	17.44	506.44	16,523	16.47	454.00	32,393	46.64	414.75	126,175	89.55	389.55
5-May-2010	23:00	17.51	506.51	16,676	16.15	453.68	31,250	46.31	414.42	125,815	89.53	389.53
5-May-2010	24:00:00	17.64	506.64	17,053	15.90	453.43	30,357	46.08	414.19	121,576	89.69	389.69
6-May-2010	1:00	17.70	506.70	17,171	15.69	453.22	29,656	45.69	413.80	119,781	89.52	389.52
6-May-2010	2:00	18.09	507.09	18,519	15.52	453.05	29,125	45.35	413.46	120,560	89.34	389.34
6-May-2010	3:00	18.26	507.26	19,041	16.27	453.80	31,679	44.85	412.96	109,480	89.25	389.25
6-May-2010	4:00	18.17	507.17	18,523	16.63	454.16	32,906	44.51	412.62	116,246	89.13	389.13
6-May-2010	5:00	18.26	507.26	18,793	16.82	454.35	33,500	44.00	412.11	104,591	88.98	388.98
6-May-2010	6:00	18.42	507.42	19,444	16.96	454.49	33,938	43.53	411.64	105,018	88.84	388.84
6-May-2010	7:00	18.59	507.59	20,045	17.04	454.57	34,188	43.00	411.11	99,200	88.66	388.66

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Cumberland River Damage Centers Hourly Water Control Data -> 29 April - 07 May 2010												
Date	Time	Celina Stage ft	Celina Elevation ft	Celina Flow cfs	Carthage Stage ft	Carthage Elevation ft	Carthage Flow cfs	Nashville Stage ft	Nashville Elevation ft	Nashville Flow cfs	Clarksville Stage ft	Clarksville Elevation ft
6-May-2010	8:00	18.73	507.73	20,515	17.08	454.61	34,312	42.53	410.64	100,726	88.55	388.55
6-May-2010	9:00	18.89	507.89	21,090	17.16	454.69	34,562	41.89	410.00	94,873	88.33	388.33
6-May-2010	10:00	19.03	508.03	20,848	17.17	454.70	34,594	41.43	409.54	96,928	88.22	388.22
6-May-2010	11:00	19.17	508.17	20,530	17.16	454.69	34,562	41.09	409.20	101,022	88.05	388.05
6-May-2010	12:00	19.63	508.63	21,563	17.28	454.81	34,938	40.60	408.71	92,436	87.87	387.87
6-May-2010	13:00	19.72	508.72	21,767	18.38	455.91	38,500	40.25	408.36	97,244	87.73	387.73
6-May-2010	14:00	19.90	508.90	22,174	18.92	456.45	40,429	39.76	407.87	89,380	87.54	387.54
6-May-2010	15:00	19.73	508.73	21,789	19.73	457.26	43,139	39.31	407.42	89,557	87.37	387.37
6-May-2010	16:00	20.11	509.11	22,646	19.69	457.22	43,028	38.79	406.90	83,964	87.18	387.18
6-May-2010	17:00	19.88	508.88	22,129	19.02	456.55	40,786	38.36	406.47	86,932	86.98	386.98
6-May-2010	18:00	19.87	508.87	22,106	18.65	456.18	39,464	37.92	406.03	84,840	86.82	386.82
6-May-2010	19:00	20.28	509.28	23,027	18.46	455.99	38,786	37.48	405.59	83,492	86.64	386.64
6-May-2010	20:00	20.03	509.03	22,467	18.33	455.86	38,321	37.13	405.24	86,130	86.41	386.41
6-May-2010	21:00	20.06	509.06	22,534	18.39	455.92	38,536	36.74	404.85	83,712	86.16	386.16
6-May-2010	22:00	20.15	509.15	22,736	18.30	455.83	38,214	36.38	404.49	83,961	85.93	385.93
6-May-2010	23:00	20.27	509.27	23,005	18.02	455.55	37,250	36.02	404.13	83,099	85.80	385.80
6-May-2010	24:00:00	20.33	509.33	23,139	18.07	455.60	37,417	35.73	403.84	84,729	85.61	385.61
7-May-2010	1:00	20.56	509.56	23,675	18.98	456.51	40,705	35.41	403.52	82,528	85.40	385.40
7-May-2010	2:00	20.53	509.53	23,604	19.56	457.09	42,727	35.12	403.23	82,521	85.19	385.19
7-May-2010	3:00	20.61	509.61	23,794	19.96	457.49	43,891	34.85	402.96	82,198	84.97	384.97
7-May-2010	4:00	20.69	509.69	23,983	20.29	457.82	50,306	34.63	402.74	83,012	84.74	384.74
7-May-2010	5:00	20.76	509.76	24,149	20.42	457.95	47,452	34.34	402.45	79,613	84.56	384.56
7-May-2010	6:00	20.82	509.82	24,292	20.57	458.10	48,347	34.10	402.21	80,254	84.29	384.29

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Appendix G – Photographs

Appendix includes photographs of Old Hickory Lock and Dam, Cordell Hull Lock and Dam, Cheatham Lock and Dam, and Nashville.

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The U.S. Army Corps of Engineers Nashville District operated area dams along the Cumberland River and its tributaries to minimize flooding and reduce lake levels during heavy rainfall and flooding on May 1-2, 2010. Tennessee and southern Kentucky received record rainfalls during the two days.

Record high lake elevations were recorded at dams J. Percy Priest in Nashville; Old Hickory in Hendersonville, Tenn.; and Cheatham in Ashland City, Tenn.

(Left) An aerial view of Cheatham Lock and Dam in Ashland City, Tenn.

U.S. Army Corps of Engineers photo

Cheatham Lock and Dam May 2, 2010

Flood waters crested in downtown Nashville at 51.86 feet reaching 1st and 2nd streets.

Nashville May 3,2010

Photo by Mark Rankin, U.S. Army Corps of Engineers

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Old Hickory Lock & Dam May 2, 2010

Large chunks of trees and debris sit on top a ledge that houses a crane at the Old Hickory dam powerhouse. The debris lifted the crane off its roller.

Water behind the dam in Old Hickory Lake reached a record elevation of 451.4 on Sunday afternoon, just seven inches short of the Corps losing control of the project due to the lake overtopping the dam. Corps engineers are collecting and studying data to verify exactly how much flooding Corps dams actually prevented. Current data shows that Corps reservoirs have prevented more than a million cubic feet per second in water from reaching the Cumberland River over the weekend.

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Cordell Hull Lock & Dam

Large Debris pushes against the Cordell Hull dam during the storms May 1-2.

Trees and Debris litter a large portion of the area below the dam at Cordell Hull. May 3, 2010

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Cheatham Hull Lock & Dam

The Cheatham Lock and Dam Lockmasters office and master control center was totally submerged underwater on May 2, 2010 when more than 13 inches of torrential rains fell.

The record rainfall was labeled as what water managers refer to as a 1,000 year event. A 1,000 year rain event has a 0.1% chance, or a 1 in 1,000 chance, of happening every year.

This unprecedented event stretched the capabilities of the ten Corps dams on the Cumberland and its tributaries, but the projects have performed as designed.

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Nashville Flooding

The Opryland Hotel was flooded when high flood waters breeched levees on the Cumberland River during the May1-2 flood in Nashville. Photos taken May 3, 2010.

1st and 2nd streets down town Nashville were flooded with 10 feet of water covering the train station and Demonbreun Street.

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Appendix H – Lessons Learned

The issues have been grouped by the following categories:

Communication	(Issues 1 through 5)
Emergency Management	(Issues 6 through 17)
Water Management	(Issues 18 through 27)

The issues are not in any particular order within the category.

Category: Communication

1. Issue: Improve integration with the United States Geological Survey.

What was planned?

-Maintain communication and cooperation between the Corps, National Weather Service (NWS) and United States Geological Survey (USGS) during a flood event.

What actually happened?

-The Kentucky and Tennessee USGS Water Science Centers (WSCs) were under-utilized by LRD, LRN and the NWS during the event. The USGS wanted to be better integrated with the LRD, LRN and NWS response in the midst of the event. During the event, USGS deployed personnel in the field to take flow measures at key locations, improve stage-discharge rating curves and repair equipment. They could have also provided real-time observations.
-The USGS could not assist in maintaining operation of critical gages during the event since they were not aware of what gages were critical.
-The USGS could not insure the critical gage readings were obtained during the event since they were not aware of what gages are critical or what the critical flood levels are.
-The NWS Ohio River Forecast Center (OHRFC) did request high water measurements on Sunday morning for the Harpeth River and utilized the information received in its river modeling.

Why did it happen?

-LRN withdrew from the USGS Cooperative Gaging Program approximately 5 years ago and ended its direct working relationship with the USGS.
-The LRD, LRN and the NWS did not consider involving the USGS in the LRD led conference calls.
-The USGS did not contact the LRN WM or the NWS to see if they needed assistance until after the crest and the river began to recede.
-Critical gages and gage ratings have not been communicated to the USGS. LRN WM has contracted gage maintenance during the last five years. The gage rating curves have not been updated during this period.
-Past budget decisions and priorities may have impacted gage maintenance.

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How can we do it better and who has the lead to fix it?

-District Water Management offices will invite USGS to participate in conference calls.
-LRN has established a transition plan to enter the USGS Cooperative Gaging Program.
-LRD WM will evaluate the use of NWS Chat.
-LRN and the NWS OHRFC and the NWS Nashville WFO will provide the USGS with a listing of critical gages such that they can assist in maintaining their operation during flood events.
-The local NWS WFOs will provide the Kentucky and Tennessee USGS a listing of all critical flood stages and major flood levels. Manual readings (stage and flow) for sites where major flooding is occurring, where gages are out (overtopped, etc.) or where readings are above current ratings are valuable to the NWS. The USGS will be able to monitor these locations during flood events.
-LRN WM will evaluate having high level staff gages at various locations that can be used during record flood events.
-USGS, NWS, and the Division Water Management offices will conduct annual office visits. Participation will also continue in the Ohio Valley Tri-agency meetings. Many offices participate annually, but will need to require attendance by all affected offices to ensure important topics are discussed.

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Category: Communication

2. Issue: Improve internal communications before and during potential flood events.

What was planned?

-Provide communication regarding potential for flooding.

What actually happened?

-On Wednesday, April 28th, LRD noted the high QPF and began monitoring the storm. The Early Morning Weather and River Update issued that day discussed the rainfall potential and noted that reservoir releases would increase over the next several days in response to the forecast rainfall.

-On Thursday, April 29th, the NWS Quantitative Precipitation Forecast (QPF) continued to show 3-6" of rainfall and LRD issued a Flood Potential Update apprising the senior leadership, the LRN Commander, Emergency Operations and Public Affairs of the upcoming rainfall event. The LRN Commander responded with LRN measures being taken in response to the QPF. This email did not get immediate attention by LRD staff resulting in slower communication up the chain of command regarding the potential severity of the event.

-LRD WM only issues the Flood Potential Updates when there's a significant event forecasted.

-LRD WM and the NWS OHRFC began coordinating the flood potential on April 28th.

Why did it happen?

-The emails were not read, perhaps from an overload of emails in mailboxes.

-A trigger does not exist at the Division staff level to activate the staff into an emergency mode. Note that this would be the Crisis Action Team according to the LRD Emergency Operations Center's (EOC's) standard operating procedures.

How can we do it better and who has the lead to fix it?

-LRD WM will add the District EOCs to its distribution list for the Early Morning Weather and River Update.

-The Division office will utilize telephonic notification for passing critical notifications.

-The Deputy District Commander will develop a trigger for significant events that would convene an emergency meeting of key staff. The staff would then have the opportunity to:

1. Receive briefing on the developing situation to ensure common understanding
2. Allow the impacted district(s) to request support and identify resources needed.
3. Have each staff officer explain what they are doing, what they plan to do to support, and any issues. This ensures all resources and support are brought to bear on the situation as well as to synchronize efforts.
4. Allow the commander an opportunity to give intent and guidance to everyone.

-An alternate trigger may be developed that activates a Division Team for coordination across functions. The Team should include as a minimum, the Deputy Commander, Water Management, Emergency Management, Public Affairs Office (PAO), Counsel, Operations, and Dam Safety.

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Category: Communication
3. Issue: Provide redundant communication systems.

What was planned?
-Communicate with project personnel concerning project release updates during the flood event.

What actually happened?
-Internet outage occurred due to a Verizon communication line break.
-The network outage that occurred on May 2 (Sunday) during a critical period eliminated the electronic transmission of project data to the Water Management Office. The only source of project data was via telephone conversations with the operators located at the projects.
-The outage impaired the ability of the Water Management personnel to quickly analyze and respond to changing conditions.

Why did it happen?
-The hydropower operators hand-enter project data into a spreadsheet system that is subsequently transferred via the network to the District Office where it automatically updates both the water control database and the web-site. Data is also transmitted via satellite to a local downlink station located at J. Percy Priest project office. The data from the local downlink is also transmitted to the District via the Internet. When the network went down these processes became inoperable.

How can we do it better and who has the lead to fix it?
-LRN WM will build redundancy into the project data reporting system to update an external database that is independent from total reliance on the network. This could be a web-site that is populated automatically as the routine data is transferred to the water control data system. In a scenario like the May 2010 flood event this may require additional capabilities at the projects to connect with the internet independent of the network.
–Air cards and laptops are being secured for the Water Management Office and for the manned powerhouses to facilitate information exchange.
-Satellite phones are being secured for the Water Management Office and the manned powerhouses as a backup for landlines and cell phones, both of which are prone to failure during certain natural disasters.

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Category: Communication
4. Issue: Improving risk communication.

What was planned?
-Provide effective risk communication to the public.

What actually happened?
-LRN WM fielded several questions from the public during the event regarding the physical extent of the areas that have the potential to be flooded based on the NWS stage forecasts. There is also a misconception of which projects provide flood control benefits. This is particularly true for the Nashville area, downstream of Old Hickory Dam where the public associates the upstream dam with flood protection rather than for navigation.
-LRN WM personnel fielded numerous phone calls from the public during the flood event requesting information on the extent of flooding expected in their area. With minimum personnel available the calls diverted staff time away from developing and implementing reservoir system operation plans.

Why did it happen?
-NWS forecast are provided in terms of river stage with some associated reference points/impacts.
-This event occurred over the weekend, when limited personnel were in the District office to handle communication with the public.
-A common public misperception is that all navigation projects hold back floodwaters just like flood control projects.
-NWS is responsible for providing the public flood forecast information; however, most people appear to associate that responsibility to the Corps.

How can we do it better and who has the lead to fix it?
-The Corps (LRN-EC-H) and the NWS Nashville WFO will develop an interagency process that relays crest stage information in a manner that gives the general public more knowledge as to the effect on an individual, i.e. what does 51.5' Nashville river stage mean for Pennington Bend?
-Inundation maps available to the public would be beneficial. Model-based GIS inundation map products could be developed for a range of river stage values. NOAA, USGS and Corps are developing an Integrated Water Resources Science and Services (IWRSS) Memorandum of Understanding (MOU) to create a technical team to evaluate inundation maps as part of the data synchronization team. Options are being explored for publishing these maps in a forum that would enhance the protection of public health and safety.
-The LRN and LRD public affairs offices will develop operating procedures that ensure all public affairs communication functions are adequately covered, such as handling media inquiries, media interviews, message development, fielding calls from the public, visual capturing support and other essential strategic communication (STRATCOM) functions.
-Affected Corps Districts will have a small number of people dedicated to answering telephone calls in order to give consistent information to callers.
-LRN will increase risk communication discussions with the public to improve awareness of the operations of Corps project and the flooding risks.

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-Silver Jackets[21] can assist in education of the public through their members. The Silver Jackets can also serve to improve communications between all stakeholders for flood risk management.

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[21] **The Silver Jackets program is a program through which the US Army Corps of Engineers, Federal Emergency Management Agency, State FEMA, and State Department of Natural Resources, and other Federal and State agencies collaborate to develop and implement solutions to State natural hazard priorities. The Silver Jackets Program provides a formal and consistent strategy for an interagency approach to planning and implementing measures to reduce the risks associated with natural hazards. The program's primary goals are to leverage information and resources, improve public risk communication through a united effort, and create a mechanism to collaboratively solve issues and implement initiatives.**

Category: Communication
5. Issue: Improve District recall of personnel.

What was planned?
-Assure that appropriate District personnel were on hand to provide assistance during the event.

What actually happened?
-The LRN District office was minimally staffed as the event developed on Saturday.
-Many of the district's personnel were being impacted by the flood. The extreme weather made it difficult and in some cases impossible for personnel to return to duty at the district headquarters. The staff at the district headquarters had to divide their time between regular duties and answering public inquiries.
-A 100% accountability procedure (phone tree) was implemented Sunday to establish accountability of personnel and to check on their status.
-The district recalled critical personnel to duty but there was no clear communication of who was considered "non-essential" personnel versus "essential" personnel.

Why did it happen?
-The event unfolded over a weekend; hence, the office was not staffed as it would have been on a weekday.
-LRN office closed on Monday as well. Only essential personnel asked to report.
- The flood directly impacted many staff members who experienced great obstacles in travel around the city.

How can we do it better and who has the lead to fix it?
-LRN will evaluate, update and revise their recall processes and system.

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Category: Emergency Management

6. Issue: Sustain communications between LRN Emergency Management and the Tennessee Emergency Management Agency.

What was planned?

-Effective communications.

What actually happened?

-A line of communication between the Tennessee Emergency Management Agency (EMA) and the LRN EOC was established.
-The EOC personnel felt that they would be more effective if they had a data sheet from the subject matter experts dealing with each event so that the EOC can speak accurately about relative topics.
-Communication with the State of Tennessee Emergency Management Agency went very well. The Emergency Management Liaison embedded in the State EOC, was able to coordinate delivery of supplies within hours of being requested: and was able to supply them with information concerning PL 84-99.
-LRN conducted numerous conference calls
-The LRN EOC has three assigned personnel. One person was assigned to the State EOC. The remaining two personnel maintained EOC operations at the district headquarters and provided technical assistance to other local agencies.
-Effective communication with the EM in Memphis District was maintained throughout the event.

Why did it happen?

- The LRN EOC has well established and understood standard operating procedures.

How can we do it better and who has the lead to fix it?

-LRN EM will work with LRN Engineering and Construction Division to establish a standard data sheet from subject matter experts so that the EOC personnel can speak accurately about relevant topics.
-The LRN EM Office will provide basic emergency management training for district personnel to ensure all personnel understand their role during response operations.

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Category: Emergency Management
7. Issue: Sustain Emergency Management Operations.

What was planned?
-The LRN EM office provided timely response efforts in accordance to Public Law 84-99 (provides the authority to conduct emergency preparation and response activities for a flood fight) and Public Law 93-288, Robert T. Stafford Relief and Emergency Assistance Act

What actually happened?
-LRN initiated their All Hazard Plan (Draft) during this event. The plan provided an effective framework for responding to the event.
-LRN EM established a liaison with the Tennessee State EM Operations beginning May 2, 2010.
-LRN followed the All Hazard Plan and LRD EM SOP during the event.
-Under Public Law 84-99 LRN provided equipment and Technical Assistance and sandbags to the state or local governments.
-The district smoothly transitioned to support under Public Law 93-288 Robert T. Stafford Relief and Emergency Assistance Act. Emergency Support Function (ESF) # 3 support was established on May 5, 2010. A Team Leader and LRN EM office continued to provide support to FEMA at the State EMA and Joint Field Office (JFO).

Why did it happen?
-LRN EM Office has well established, rehearsed and coordinated procedures.

How can we do it better and who has the lead to fix it?
-LRN EM will distribute and store sandbags throughout the Tennessee and Cumberland River basins to ensure faster response to sandbag requests.
-The District will augment the LRN EM Liaison with the appropriate subject matter expert from the district (or externally augmented) who is well versed in the type of event occurring.

DRAFT

Category: Emergency Management
8. Issue: Efficient use of ENGLink.

What was planned?
-Effective usage of ENGLink.[22]

What actually happened?
-The LRN EOC specialist was very adaptable and eager to learn some new techniques as the event progressed.
-EOC members need to have all rights as a Strike Team member.
-Enlisted the help of a LRN Strike Team member (Navigation Branch) to assist in the preparation of the RO Doc and the tasker process. This helped EOC personnel greatly by allowing the smooth transition of taskers.

Why did it happen?
-Standard Operating Procedure.

How can we do it better and who has the lead to fix it?
- LRD EM will continue to provide training so that EOC personnel can perform their duties in ENGLink more efficiently.

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[22] **ENGlink is the software program use by USACE to manage information, execution and personnel in response to an event. It also contains a database of all Corps personnel to document physical status, training and essential personnel data.**

Category: Emergency Management
9. Issue: Sustain pre-event coordination.

What was planned?
-In accordance with (IAW) with proven Business Line practices LRD-EM coordinated calls with LRD WM and the potentially impacted Districts (LRL/LRN).

What actually happened?
-LRD EM remained in close coordination with both LRL and LRN EM a week in advance of the May 1, 2010 flood event. The EM offices had been working response to storms in the Midwest the week prior. On April 28th the LRD WM office sent an update that indicated heavy precipitation west of the Ohio River Basin. EM and WM offices have a long standing practice of sharing information on a routine basis, anticipating potential impacts, and posturing for a timely effective response.
-The LRD EM office maintained coordination with the USACE Operations Center and other Major Subordinate Command through the use of daily conference call that started on April 28. Water Management participated in these coordination calls and briefs.
-Coordination with HQUSACE and identification of appropriate ESF #3 personnel to staff key C2 positions at FEMA IV and IMATs prior to the actual May 1, 2010 flood event.
-Temporary duty cancellation on April 30, 2010 for LRD-EM and MVM-EM scheduled to attend ESF #3 ATL workshop the week of May 2, 2010 in anticipation of the potential flooding. Experienced the opposite of this during the Kentucky Winter Storms; repeat averted.
-Ironically, LRD and representatives from our seven District EM offices participated in a Response Mission Workshop (April 21-22, 2010), coordinated by LRN-EM, with TEMA where each of our Districts presented Mission PRT specific operational briefs. Would also note participants included FEMA IV, TVA, and MVM representatives.

Why did it happen?
-LRD along with the seven District offices utilized the accepted and best practices procedures which have been in place for years. The Lead Districts for each state work closely with their state counterparts on training, exercises and yearly briefings on the Corps Authorities and missions assigned by FEMA during a declaration.

How can we do it better and who has the lead to fix?
-Sustain this activity.

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Category: Emergency Management
10. Issue: Sustain response phase activities.

What was planned?
-An effective, coordinated, and timely response under Corps authorities and missions assigned under the National Response Framework.

What actually happened?
-Pre-event posturing of appropriate resources was critical in our timely and effective deployment of ESF #3 personnel to FEMA IV RRCC and TN IMAT in support National Response Framework activities was on target. Our ESF #3 TL arrived on time and date requested by FEMA IV as well as our TL on the TN IMAT arriving in Nashville ahead of FEMA personnel.
-Under our Corps Authority (PL 84-99) LRN-EM responded to and fully supported TEMA requests for flood fighting. From issuing sandbags, providing Technical Assistance, to embedding a District EM in TN EOC, no unanswered request for Corps assistance. In one particular case, the LRN-EM utilized reach back to a sister District (LRL) to virtually provide effective TA and develop an appropriate course of action to sandbag a communications facility potentially impacted by the rising waters.
-With one of the two Water Treatment Plants that supplies Nashville's drinking water impacted and off line, important to note that sandbagging assistance coordinated by LRN-EM office with TEMA greatly mitigated impacts to the remaining facility as it remained online.
-Internal to Corps, with one of the LRN Projects (Cheatham) severely impacted and without communications, EM's timely and effective deployment of RRV #3, quickly established a communications platform for District personnel engaged in project recovery operations.
-Additional seamless coordination activities undertaken to mitigate impact to District resources was the utilization of National resources in support of RSOI processing and FEMA Mission Assignments. With regards to RSOI, ULA assets at LRD were engaged to successfully accomplish for personnel arriving into the AO. RAO personnel identified and deployed to support PDA and PWS activities, here again, minimizing impacts to LRN's active workforce.

Why did it happen?
-Proven Business Practices that are validated during the annual SOP Week, Corps/FEMA Remedial Action Program, the SLS and annual National Response Mission exercises. The Corps trains the way we fight.

How can we do it better and who has the lead to fix?
-Sustain this activity.

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Category: Emergency Management
11. Issue: Sustain recovery phase.

What was planned?
- Execution of missions under the Stafford Act.

What actually happened?
-Six mission assignments were issued by FEMA Region IV to LRD. Division Office has the responsibility for executing the Regional Activation and the Nashville District is responsible for executing all other
-Not anticipating issues; will consist of the orderly physical and fiscal closeout of FEMA

Why did it happen?
-The Corps has well understood business practices that are exercised and validated annually with partner agencies.

How can we do it better and who has the responsibility?
-Sustain this activity.

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Category: Emergency Management
12. Issue: Improve logistics response.

What was planned?
-During an event, seamless communication will be maintained between the Division Logistics Staff (Regional Logistics Liaison, Regional Logistics Planner, and Logistics Management Specialist) and the affected District Logistics Staff (Logistics Delivery Point) to allow proper situational awareness and to facilitate rapid planning or the response effort.

What actually happened?
-Communication and information flow was extremely limited during the early phases of this event. Various members of the logistics team were aware of different pieces of information before and during the weekend flooding event, which should have caused joint logistics preliminary coordinating meetings, an almost instinctive and intuitive sense for collaboration.
-LRD Logistics filled this leadership void and provided necessary guidance and priorities.

Why did it happen?
-The combination of the ULA Logistics Activity Center (LAC) displacement without communications due to floodwaters at the Naval Air Station, Millington, TN, and the rapidly evolving events in the Nashville area hindered the transfer of information and guidance to properly plan the support effort.
-The RLL, Regional Logistics Planner (RLP), and Logistics Delivery Point (LDP) should have conducted teleconferences early in the event to ensure all logistics support requirements were well defined and activities were being conducted to satisfy those requirements.
-The RLL and RLP should have better communicated the requirements and status with the ULA Logistics Planning and Operations Division (LPOD) and leadership.

How can we do it better and who has the responsibility to fix it?
-The Regional Logistics Liaison (RLL) will develop a standard operating procedure (SOP) as to when to start preliminary coordinating meetings.
- For any event, RLL, RLP and Logistics Management Specialist (LMS) will establish and maintain clear and effective communications from the onset.
- LRD Logistics Management will develop a logistics battle rhythm early in every operation that outlines all communication and reporting requirements. This Battle Rhythm will anticipate a 24-hour presence, and therefore prepare for possible reach-back support if continuous operations are anticipated to last longer than 7 days.

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Category: Emergency Management
13. **Issue: Improve continuity of operations for the ULA.**

What was planned?
-Clear lines of succession of the ULA leadership and key, critical tasks performed at the ULA Logistics Activity Center (LAC) to allow continuity of operations if access to the LAC is denied.

What actually happened?
-The effect of ULA leadership / guidance, reach-back support, and potential Logistics Planning and Response Team (LPRT) deployment during timeframe when LAC operation was impacted due to the flood in Millington, TN which prevented access to the LAC for 5 days.
-If a LPRT had been required during the early phase of this event, the ULA may not have been able to rapidly deploy a logistics team to assist the response effort.

Why did it happen?
-ULA Continuity of Operations Plan (COOP) was not finalized and key participants did not know their roles in the event of ULA COOP execution.

How can we do it better and who has the responsibility to fix it?
-ULA will finalize its Continuity of Operations Plan (COOP) to ensure critical tasks can be performed if its facilities are damaged or inoperable.
-The ULA will train and exercise the COOP plan after it has been developed.

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Category: Emergency Management

14. **Issue: Improve the Logistics support plan for no-notice events.**

What was planned?

-LRN Logistics Delivery Point (LDP) will execute its 24-36 hour support plan when needed to support response to a no-notice event. Its plan will cover all facets of logistics support required to provide Reception, Staging, Onward movement, and Integration (RSOI) and initial life support to all responders processing into the affected zone.

What actually happened?

-Although LRN LDP staff effectively executed their support plan, this event showed the criticality of having an updated 24-36 hour plan and battle book to facilitate support during the early phases of a no-notice event. The plan should specifically outline what support will be provided to the EOC, district Crisis Management Team / Crisis Action Team, and incoming responders, as well as, who and how this support will be provided.

Why did it happen?

-The 24-36 hour support plan contained the guidelines to support any no-notice event, however, the magnitude of this event demonstrated additional detail and support planning is required within the plan.

How can we do it better and who has the responsibility to fix it?

-LRN LDP will update their plan and battle book based on lessons learned from this event.

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Category: Emergency Management
15. **Issue: Improve resourcing of the Logistics Planning and Response Team.**

What was planned?
-All Logistics Planning and Response Team Members will deploy with the necessary equipment to conduct RSOI and logistics support operations.

What actually happened?
-LPRT members did not have (deploy with) required equipment. Both members of the LPRT deployed with personal cell phones.

Why did it happen?
-The individuals were not pre-issued government cell phones. The ULA does not have additional equipment to issue all members on deployment teams. To be fully effective, each member of the LPRT requires a laptop, with air card, portable printer, and a government issued cellular phone, preferably BlackBerry to sync with email. In this case, they could have secured phones from FEMA due to the FEMA logistics tail being fully set up, however, in other situations, each member must deploy with the equipment that will enable the team to operate and communicate during events where communications may be disrupted for extended periods of time prior to FEMA being available to provide such support.

How can we do it better and who has the responsibility to fix it?
-LPOD will develop and procure fly-away kits; the kits must contain phones and portable computers that can be used to access the internet (ENGLink and Webmail) to assist with RSOI.

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Category: Emergency Management
16. **Issue: Improve logistics personnel ability to use ENGLink.**

What was planned?
-The supporting logistics personnel (LDP and LPRT) will assist the EOC with receiving and in-processing all responders in ENGLink Interactive. All logistics personnel will be trained in the logistics attributes and functions within ENGLink.

What actually happened?
-The efforts of the deployed LPRT and district LDP personnel greatly assisted in the overall success of the mission. They in-processed 48 responders and ensured they had the proper paperwork and equipment. Once the LPRT members re-deployed to home station, the LDP staff resumed operations to ensure mission accomplishment.
-The only shortfall was proficiency in ENGLink processing. Not all logistics support members were familiar and proficient in the logistics and deployment module sections of the database.

Why did it happen?
-Key contingency logistics support personnel throughout the ULA are not familiar or proficient with ENGLink to effectively conduct RSOI operations. ENGLink training is neither a requirement for LDP staffs nor every member of LPRTs. Whether a LDP is executing its 24-36 hour support plan or an LPRT performing RSOI, there are several logistics functions, reports, and other tools in the system, which are vital to personnel / equipment accountability and overall success of any operation. For example: the logistics personnel supporting the operation must ensure the reporting instructions and RSOI details are provided to the EOC to ensure tasker templates are updated so responders know where to report, what lodging arrangements have been secured, etc.

How can we do it better and who has the responsibility to fix it?
-The ULA will add ENGLink Logistics / Deployment Module training to the Master Training Plan for all Regional Planners, LPRT members, Regional Logistics Liaisons, and LDP Chiefs.

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Category: Emergency Management
17. **Issue: Develop duty descriptions for logistic team members.**

What was planned?
-Each logistics team member supporting an event should be assigned an appropriate duty description on a tasker in ENGLink.

What actually happened?
-Each logistics member supporting this event, not deployed as part of a LPRT, was tasked using the "Logistics Officer/Subject Matter Expert" duty description.

Why did it happen?
-Currently, there is no way to accurately select a LDP chief, LDP supply specialist, or transportation specialist for a tasker within ENGLink. The ENGLink system allows for requesting an individual with specific skill sets that are differentiated by the duty description, however, all applicable logistics duty descriptions have not been created.
-To effectively assign logistics team members to an event in ENGLink, duty descriptions must be available for every position within the LDP staff, RLP, and the RLL.

How can we do it better and who has the responsibility to fix it?
-ULA / LPOD will create duty descriptions for each applicable position (RLP, RLL, and LDP staff members) and work with ENGLink / RSC to update the Duty Description database.

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Category: Water Management
18. Issue: Improve awareness of project maintenance status.

What was planned?
-Knowledge of the availability and use of turbines and spillway gates for use to manage project releases.

What actually happened?
-Old Hickory hydropower unit #4 was out of service during the event. This was an unscheduled outage. Unit #4 has been off-line for several months.
-Old Hickory spillway gate #1 was out of service during the event for scheduled maintenance. There was a bulkhead in place at the time of the flood that was overtopped when the lake level exceeded elevation 447.5. The other five gates were available and used extensively during this event.
-One of the four spillway gates at J. Percy Priest Dam did not operate initially when spillway gate releases were initiated late on May 3 (Monday). An Old Hickory Power Plant electrician was called in and within 30 minutes had diagnosed and repaired the problem. The repaired gate was then immediately put in service to prevent it from being overtopped.
-While all gates were mechanically available at Barkley Dam, they could not all be operated at the same time due to a submergence issue associated with exceptionally large project releases.
-While there were individual gate or turbine outages at other plants, none were of the nature to significantly impact project operations during the flood.

Why did it happen?
-Hydropower unit and spillway gate outages are common occurrences associated with operating and maintaining multi-purpose projects with individual components that have in some cases far exceeded their design life.
-The LRN Hydropower staff, both in the District Office and at the projects, routinely coordinates with Water Management on any outages that impact the ability of the project to release water. That was the case for Old Hickory where Water Management was aware that hydropower unit #4 was not available and that one of the spillway gates had been taken out of service for maintenance. The issue with the spillway gate at J. Percy Priest did not become apparent until it was being operated during the event.
-With Old Hickory spillway gate #1 not available during this event it forced the five available gates to be operated at larger gate openings. The maximum gate opening during this event was 34 feet. The maximum gate opening for Old Hickory spillway gates is 42 feet. Therefore, with one gate not readily available the project was still able to pass the required flow.

How can we do it better and who has the lead to fix it?
-LRN will develop and disseminate a tracking system that identifies in real-time what project components (turbines, spillway gates, sluice gates, fixed cone valves, etc.) are available for use.
-Water Management and LRN Operation elements responsible for scheduling maintenance outages will enhance communication to ensure that scheduled maintenance can be performed at the best time with respect to water control operations.

DRAFT

Category: Water Management
19. Issue: Improve triggers for activation of Water Management offices.

What was planned?
-Maintain Water Management operations during a flood event.

What actually happened?
-LRD was in communication with the OHRFC since Wednesday.
-On Friday, April 30, LRD WM directed the District offices to work the weekend. LRD staffed its office for Saturday and Sunday during morning business hours.
-On Saturday, LRD initiated communication with TVA/LRN/NWS anticipating the need to initiate lower Ohio/Mississippi River flood control operations. LRD did not arrange for 24-hour staffing because TVA River Scheduling staffs 24/7 routinely and has standing orders to contact LRD personnel at home during rapidly changing conditions. LRD does not have enough water management staff to man the office on a 24-hour basis. LRD WM does not have a Standard Operating Procedure for 24-hour operation.
-LRN typically staffs the Water Management office with one water manager on weekends and holidays. During routine operations all evaluations and coordination are complete and the necessary instructions issued to the projects by noon. LRN WM does not have a Standard Operating Procedure for 24-hour operation.
-LRN WM followed established procedures by staffing the office with a highly experienced water manager on Saturday morning. The water manager, through coordination with other personnel and the Water Management Section Chief, implemented a number of measures to respond to changing conditions. Prior to leaving at 1340 hours, the water manager issued a number of instructions to operators at the projects on how to respond to changing water conditions. As part of their normal operating procedures, LRN WM provided project status and forecasts for the flood control projects to LRD WM. In turn, LRD WM provided this information to the NWS OHRFC in the morning report.
-Morning reports are provided to the NWS OHRFC.
-There was a 15.5 foot rise in the Nashville gage on Saturday, most of which occurred during the afternoon.
-Kentucky and Barkley pools rose 4 feet from Saturday night to Sunday morning.
-LRN WM (senior water manager that worked earlier in the day and the Section Chief) returned to the office at 1900 hours to complete a supplemental evaluation of rainfall, runoff, and project conditions and to make any needed adjustments. Prior to leaving the office at 2300 hours a new set of instructions (including when to call during the night for additional guidance) were issued to the projects and an e-mail was sent out to LRN management and LRD WM. LRD WM forwarded the LRN WM email to the NWS OHRFC at 0416 hours Sunday morning. NWS OHRFC read the email at 0700 hours.
-NWS OHRFC attempted to contact LRN WM Saturday evening and Sunday morning prior to anyone coming to office.
-Conference calls between LRN and the NWS OHRFC began at 0830 hours on Sunday.
-The LRN WM Section Chief contacted staff on Saturday evening and made arrangements for 24-hour operations to start with the 0630 hours shift on Sunday morning. The office was staffed around the clock until 2200 hours Tuesday night.
-The NWS WFO maintains 24/7/365 operations.

DRAFT

-The NWS Nashville WFO has a Nashville Hydrologic Program Manual which contains at least one off-hour contact number for LRN.

Why did it happen?

-LRD and LRN WM followed established protocol for weekend and after-hours work. The offices were staffed during Saturday morning, instructions were issued, and project staff knew to call if they needed additional guidance. The situation at the time did not appear to warrant around the clock staffing as late as Saturday afternoon.

-Early Sunday, May 2, the NWS OHRFC needed to know how LRN was operating the projects and could not contact anyone in Nashville. Calls to LRN were placed at approximately 0200 hours and 0700 hours. No voice messages were left on LRN WM telephones. Note that the NWS OHRFC standard operating procedure is to include the Corps release schedule into its forecast. The first effort to obtain this information other than the daily morning reports was on Sunday.

-The NWS OHRFC did not try to contact LRD WM until 0615 hours Sunday morning even though they had off-duty contact information. The NWS OHRFC was advised to call LRN at 0730 hours by LRD.

-The TVA River Scheduling night shift did not contact LRD WM. Inexperienced personnel were on duty and they did not know who to contact.

-LRD and LRN WM should have begun 24-hour operations Saturday to provide continuous monitoring and communications with NWS and TVA.

-Insure LRD and LRN water managers are monitoring situation in afternoon and evening hours as well.

How can we do it better and who has the lead to fix it?

-LRD WM will consider NWS Chat via BlackBerry.

-Water Management is developing a common trigger for 24-hour operations and increased communication. Trigger may be based on rate of rise, predicted crest, QPF, etc. and may be based on the basin. This will be accomplished by developing a Standard Operating Procedure (SOP) that will define when to initiate 24-hour flood operations, staff levels and schedules, and frequency of increased communication. The SOP will include how to assist Water Management due to lack of personnel (illness, etc.), loss of equipment or loss of office. The SOP will include additional support to Water Management such as administration support to answer telephones, faxes, etc. and liaisons to other offices, etc. This SOP will allow Water Management to stay focused on its mission.

-TVA and NWS OHRFC will utilize the contact information to contact personnel during off-duty hours when the situation is rapidly changing and the established triggers have not been reached.

-The Corps will share off-hours contact information and insure it is maintained with up to date information.

-TEMA can provide contact numbers for key staff at the various agencies and willing to provide assistance.

-LRN WM will share system operation plans with TVA River Operations staff. This would provide a continuous 24/7 source of information on the Cumberland River system projects.

-LRN is expanding current cross-training of LRN Water Resources and LRN WM personnel.

DRAFT

-LRD WM will evaluate the necessity to increase staff versus leveraging existing capabilities in other Water Management offices. Note that LRD WM has been approved to increase staff by 2 employees beginning in FY2012.

DRAFT

Category: Water Management

20. Issue: Improve the understanding of technical information between the Corps and the National Weather Service.

What was planned?

-Provide effective communication of project operations with the NWS.

What actually happened?

-Misunderstanding of technical information regarding the operation of Old Hickory Dam
-NWS should have considered Old Hickory Dam was in run of river operations.
-Due to the chaotic nature of the flood event and the frequency of required spillway gate changes, LRN water managers did not provide estimated Old Hickory discharges on a timely basis on Sunday, May 2. On Sunday afternoon the Corps was dealing with multiple issues along the mainstem of the Cumberland from Cordell Hull to Barkley including record discharges at several projects. Old Hickory was above the surcharge pool and near the pool of record.
-During conference calls, which began at 0830 hours on Sunday, May 2, between LRN and the NWS OHRFC, the NWS OHRFC thought that the Corps was providing them the forecast releases from Old Hickory rather than current releases. If the NWS OHRFC reservoir model indicated higher outflow, they deferred to the release information provided directly by the Corps, unless they had other data to tell them otherwise (such as real time tail water readings to confirm and/or adjust the model). Due to the lag time for flow between Old Hickory and Nashville, it could be a few hours before they recognized that the flow information provided earlier by the Corps was no longer valid.

Why did it happen?

-A misunderstanding between agencies of technical communication, i.e. LRN intended for its conversations to indicate that they were operating the gates to pass the inflow while maintaining the Old Hickory pool and that the discharges were above their gate rating curves. The NWS felt that since the Corps was operating the gates, their discharges were reflective of the current conditions.
-Corps and NWS assumed each was aware of what the other agency meant by their operations and modeling. For example, the Corps indicated on teleconferences that Old Hickory's flood surcharge pool had been utilized and assumed the NWS was aware that project was passing inflow with gate operations. The NWS OHRFC did not understand the hydraulics of the navigation project operations on the Cumberland River system under the full range of flow conditions.
-Discrepancies between NWS model outflows and Corps releases were not fully discussed or understood on Sunday as observed precipitation exceeded forecast and river stage approached critical levels in Nashville.
-Since the 1970s, the information provided to the NWS OHRFC by LRN WM during high flow events had consisted of a plan of operation for the LRN flood control projects (Wolf Creek, Dale Hollow, Center Hill, and J. Percy Priest) and not flow data from the mainstem navigation projects (Cordell Hull, Old Hickory, and Cheatham). LRD WM provided the Barkley flows . LRN understood the modeling approach used by the NWS OHRFC was to pass inflow at the mainstem projects where only the surcharge pool storage was available and to route the releases from the flood control projects to develop stage forecasts at the damage centers. LRN WM

DRAFT

employed that methodology for the data exchange when the May 2010 flood event began. The LRN senior water managers on duty had employed this same routine since 1984 on a daily basis. LRN applied this methodology during 16 high flow events resulting in a Nashville stage greater than 30 feet during this 26 year period. For the May 2010 flood event the NWS OHRFC was expecting more detailed information on releases from the mainstem projects. Once LRN realized that expectation around 2300 hours late Sunday evening, the updated spillway gate operations were routinely shared with NWS staff.
-Increased communication was delayed until late Sunday night when an OHRFC forecaster called LRN shortly after arriving on shift (approximately 2300 hours Sunday, May 2.)
-There was not an established procedure to update the project operational data after the initial morning data exchange with the NWS.

How can we do it better and who has the lead to fix it?
-The Corps and NWS will develop a better understanding and appreciation of each other's models, operations and how to alert each other of changing conditions.
-LRN will conduct annual Flood Table Top Exercises with NWS, USGS, TEMA and others as appropriate to improve understanding of reservoir system operations and strengthen communication ties among the agencies.
-LRN WM will review and revise the Water Control Manuals to insure they address extreme events and update as necessary. Extend gate ratings and update other critical guidance for above and below normal ranges.
-LRN will develop electronic updates for the tailwater conditions at the Corps dams.
-LRN will investigate options to provide real time communication with the NWS regarding water releases from Corps projects. Example: Remote monitoring of gate operations similar to gates at Smithland Lock and Dam on the Ohio River. In the short-term implement procedures for the operators at the projects to notify the NWS WFO when they make spillway gate changes during flood operations.
-LRD WM will evaluate NWS Chat to assist with communication.
-LRN WM will develop a Standard Operating Procedure (SOP) that will define the protocol and frequency of increased communication. Critical operations personnel must be able to be reached at all times (off hour phone numbers, cell phones, etc.). When critical changes are made by either the Corps or NWS, phone calls must be initiated. The SOP will include common triggers for increased communication that are coordinated with the NWS. Trigger may be based on rate of rise, predicted crest, QPF, etc. or may be based on the basin.
-LRD WM will continue working with the NWS to develop joint models.

DRAFT

Category: Water Management

21. Issue: Implement redundant Water Management Enterprise Architectural (WMEA).

What was planned?

-Maintain Water Management operations (enterprise and legacy systems) during a flood event, including.
-Uninterrupted access to water control data during the flood event.

What actually happened?

-Network outage at LRN started at 0930 hours Sunday morning and persisted until 2005 hours that night as a result of a Verizon communication line break.
-This impeded LRN WM staff's ability to obtain data and post project data.
-LRN Water Managers found alternative ways to obtain gage data, such as using personal cell phones with internet access.
-A call was placed to the Corps Information Technology Office (ACE-IT) Service Desk at 1124 hours Sunday morning. ACE-IT did not issue a ticket; however, they did respond later that day at 1930 hours with a wireless router equipped with an air card that allowed access to the internet by Water Management staff that had laptops (limited to two staff members).
-The LRN WM database is located outside of the production network which prevented access to the data when the internet failed.
-During the network outage updated information was not placed on the Corps website; therefore, it was not readily available to other agencies or the general public.
-The local readout ground station (LRGS) equipment located at the J. Percy Priest Water Management COOP site had been in-place for only a week following a lengthy outage to allow ACE-IT migration of software to an updated platform. The LRGS had experienced network issues due to local (J. Percy Priest project) connectivity and power problems at the site. There was uncertainty concerning the functionality of the LRN LRGS system. However, based on subsequent evaluations the COOP site was functional and available during the event.
-NWS not aware that LRN gage data was available on Rivergages.com
-LRN fielded numerous calls from the public requesting gage information.
-The flow of rainfall, stage, and flow data was disrupted by a prolonged network outage that occurred on May 2 (Sunday). During this time any data streams that were dependent on a functioning network were not available.
-Prior to this event LRN was in the process of relocating the water control database from outside of the production area to inside the production area. The location of the database did not interrupt the access to data during the event.

Why did it happen?

-Major network communication line (by external provider) went out during event.
-ACE-IT did not provide Priority 2 Critical Service upon request as listed in Performance Work Statement (PWS) Technical Exhibit 9 and in accordance to the ACE-IT/Water Management Memorandum of Agreement, dated August 25, 2008.
-Local ACE-IT mandated the water management database be outside the production network rather than on the water management subnet as in other offices.

DRAFT

-Under certain circumstances, ACE-IT should not be allowed to set the priorities for requested work or services related to critical water management operations.

How can we do it better and who has the lead to fix it?

-LRN is purchasing air cards, laptops and cell phones for the Water Management staff to provide redundant internet capability and evaluating alternatives for internet access.
-LRN WM will establish water management subnet with a controlled internet accessible segment and move the water management database back inside the production network.
-LRN has a local COOP site located at the J. Percy Priest Lake project. Given the close proximity of the COOP site to the Water Management Office, power, network, and/or weather related issues would likely affect both sites simultaneously. Accessibility also becomes an issue during an event like the May 2010 flood when access to the local COOP site was difficult at best during extended periods of time. Trigger points should be established that would lead to pre-positioning staff at the local COOP prior to access becoming limited.
-LRN Evaluate establishing a long distance COOP Site where a redundant database and modeling capability are maintained in a ready state. The logical arrangement would be for LRL and LRN to set up reciprocal COOP Sites.
-ACE-IT (Service Assurance Officer, CECI) will provide the service listed in the PWS Technical Exhibit 9 and the ACE-IT/Water Management Memorandum of Agreement, dated August 25, 2008. The ability to affect priorities on ACE-IT actions in preparation for and during an event needs to be enhanced.
-CWMS could not have been run during the time of the network outage. An alternate connection to CWMS at the COOP site or long distance coop will be established.
-LRN WM will evaluate a local readout ground station (LRGS) at the District office for satellite telemetered data to be received independent of the internet.
-The USGS, NWS, and Corps will provide www links between their web pages such that the public is aware that data is also available on other agency web sites.
-Corps and USGS web sites will contain notes to reflect that the NWS is responsible for river forecasts and provide a link to their web site. Note that the NWS OHRFC provides guidance to the WFOs who are responsible for issuing forecasts and warnings.
-LRN WM will complete the relocation of the water control database to within the production area. This will require a subsequent update to the method used to transmit data to the Southeastern Power Administration (SEPA).
-LRN WM will develop alternative methods to interface with water control data that are not solely dependent on the network.

DRAFT

Category: Water Management

22. Issue: Improve communication between the Corps and the National Weather Service.

What was planned?

-Provide effective communication regarding project operations with the NWS.

What actually happened?

-When the NWS OHRFC was contacted to inform them of high releases from Kentucky and Barkley Lakes, the hydrologist on duty asked LRD WM to contact the Paducah WFO directly. The NWS OHRFC did not advise LRD WM to contact the LMRFC but advised to contact the Paducah WFO. LMRFC is responsible for forecast operations downstream of Barkley.

-Failure of NWS Paducah WFO to issue a flood warning statement that would have activated the Emergency Alert System when notified of high releases from Kentucky and Barkley Lakes; instead a Special Weather Statement was issued.

Why did it happen?

-The Service Hydrologist at the Paducah WFO did not fully understand the information. The flow information that was provided was not translated to stage, thus the extent of the increase was not recognized.

-Technical communication and understanding of each agency's operations played a large role in this misunderstanding. The NWS should have asked more specific questions in order to understand the impact and the level of urgency.

-Lack of understanding of the Cumberland System at extreme flows by hydrologists and meteorologist at the NWS OHRFC and WFOs.

-NWS can only convert flows to stages at NWS rated forecast points. There are no forecast points on the Cumberland River downstream of Barkley.

How can we do it better and who has the lead to fix it?

-The Water Management office will translate flows to river height levels, as necessary, when working with the WFOs.

-LRD WM LMRFC and the OHRFC will develop an interagency process that specifies the correct language and emergency activation system levels for communicating urgent events regarding operation of Corps projects. This will ensure a common operational picture and appreciation for rapidly developing events.

DRAFT

Category: Water Management
23. Issue: Sustain pre-event water management actions.

What was planned?
-Adjust lake levels prior to rainfall event.

What actually happened?
-LRN WM makes nearly all operational decisions based on rain on the ground. The exception is a relatively short suspense (3 days or less) rainfall forecast that carries a high degree of certainty. Given that scenario it is appropriate to make adjustments to Cumberland River Basin lake levels in advance of the event to better position the system to respond to significant increases to project inflow. That was done for this event on Thursday and Friday prior to the heavy rain that began on Saturday when pool levels at Cordell and Old Hickory were lowered about 0.5 ft and Cheatham was lowered by around 1.0 ft.
-The challenge in pre-positioning lake levels is that by the time there is enough confidence in a rainfall forecast to warrant taking proactive measures there is not enough time to significantly lower lake levels and clear the water from the system to avoid merely moving the problem downstream. That was the case during this event given the situation on the Ohio River where the river was nearly at flood stage at Cairo when the Cumberland event began and a flood crest was moving down the Ohio.
-The decision to lower lake levels at the main-stem projects was based on modeling of forecasted rainfall performed by LRN WM. LRN currently has two system water control models available. The RAI Model (vintage 1978) is the production model and has been in use for more than 30 years. LRN, in conjunction with work being done by a contractor, is in the process of developing a Corps Water Management System (CWMS) application for the Cumberland Basin reservoir system. The CWMS model is a system of real-time data analysis tools and hydrologic models that will also utilize radar precipitation data provided by the NWS. The CWMS model is in draft form. It was used leading up to this event to perform simulations of forecasted rain. These model runs looked at project response at Wolf Creek and Center Hill (DSAC I dams) in addition to conditions on the Cumberland River. The simulated runs were coordinated with similar efforts performed by water managers at LRD and TVA to develop a regional view of the forecasted event.
-LRD WM issued instructions to the districts to work Saturday/Sunday. Note that LRN works all holidays and weekends.

Why did it happen?
-The adjustments made to lake levels prior to the start of the event were appropriate given the nature of the rainfall forecast. It is highly unlikely that the science behind rainfall and runoff forecasts will ever evolve to the point that lake level adjustments of a magnitude to effect significant flood crest reductions can be made in advance of a major rainfall event. A shift of only 50-100 miles of the rainfall from the May 2010 event would have completely changed the outcome.

How can we do it better and who has the lead to fix it?
-LRN WM will continue CWMS development for the Cumberland Basin and replace the older RAI model for daily production use.

DRAFT

-Water Management and the NWS will develop a program that takes advantage of tools currently either in use or under development at NWS to prepare project inflow forecasts based on the latest forecasted rainfall information. The hydrology modeling could be performed by NWS and provided to the Corps to evaluate using CWMS. The early stages of such a process are currently in place with NWS providing a daily update of inflows to Wolf Creek and Center Hill. The NWS is experimenting with several different methods of utilizing probabilistic QPF. It is currently providing (experimentally) to some of their partners the MMEFS (Meteorological Model Ensemble Forecast System).
-The Corps and the NWS will continue to evaluate a common modeling approach to facilitate a consolidated approach to hydrology and hydraulic modeling.

DRAFT

Category: Water Management
24. Issue: Improve awareness of the Quantitative Precipitation Forecasts.

What was planned?
-Awareness of QPFs issued by the NWS during the flood event.

What actually happened?
-QPFs are published twice daily, early morning and late afternoon/evening by the Hydrometeorological Prediction Center (HPC). As a result they often first become available when the LRN WM office is not staffed. As a result, revision to a QPF that may warrant action (revise project releases, increase staffing, etc.) by LRN water managers may not be seen until many hours after it was issued. During the May 2010 event the QPF published on Friday evening was not observed until Saturday morning at 0700 hours when LRN WM staff reported for duty. A review of this QPF was warranted; however, it did not impact flood operations.

Why did it happen?
-NWS publishes the QPFs on a twelve hour time basis.
-LRN water managers do not routinely check the evening QPF after duty hours.

How can we do it better and who has the lead to fix it?
-Look at another alert measure to alert key personnel.
-LRD, the Districts, OHRFC and the WFOs will update their contact lists so that the OHRFC can alert the appropriate office if significant changes occur in the evening QPF.
-LRD WM will consider NWS Chat via Blackberry.
-LRN WM will assign a Water Manager the responsibility to check evening QPFs.
-Note that the OHRFC will expand ensemble probabilistic forecasting (MMEFS – meteorological model ensemble forecast system) to all CORPS districts in the near future. MMEFS Training will be provided this summer. In addition, the OHRFC has begun to provide MMEFS inflows for Wolf Creek and Center Hill to address risk to high risk dams.

DRAFT

Category: Water Management

25. Issue: Improve situational awareness of the National Weather Service published forecasts.

What was planned?

-Awareness of crest forecast by the NWS during the flood event.
-Assist NWS by insuring that project operations do not differ from those that were used to develop the crest forecast.

What actually happened?

-NWS developed revised flood crest forecasts and LRN WM was not immediately aware of the new forecast. This occurred on Sunday evening. LRN WM was coordinating releases from Old Hickory and J. Percy Priest based on an early Monday morning crest, and was not aware that the crest had been pushed back to early Monday afternoon.

Why did it happen?

-NWS not aware that LRN WM was not receiving forecasts directly.
-LRN WM not aware of alternatives to receive the NWS forecasts.

How can we do it better and who has the lead to fix it?

-LRN WM will investigate possibility of receiving NWS forecast provided through email notification.
-LRN WM staff is acquiring Blackberries.
-LRN WM will configure LDM to receive the NWS suite of products in real-time from LRD. LDM may also be configured to provide email notification of forecasts.

DRAFT

Category: Water Management
26. Issue: Improve long term reliability of rainfall and stream gages.

What was planned?
-Continuous operation of rainfall and stream gages to provide the information necessary to support flood fight efforts.
-Repair gages as necessary during the event to support the continuous flow of data.

What actually happened?
-Operation and maintenance of rainfall and stream gages within the Cumberland Basin is executed by a combination of LRN WM staff, contract personnel, and the USGS.
-The LRN stream gaging maintenance contract expired on April 30, 2010, the day before the high rainfall for this event started. Emergency repairs were performed by LRN WM staff. Only four LRN gages were damaged by the flood. They consisted of two stream gages (Harpeth River at Kingston Springs and Bledsoe Creek at Gallatin) and two tailwater water quality monitors (Old Hickory and Cheatham). The Harpeth River site was the most critical as it is a NWS forecast point. The gage was repaired and brought back on-line within one week of when the high water flooded out the electronics. The Bledsoe Creek gage was reinstalled at a later date.
-The Tennessee USGS office contacted LRN WM on Wednesday and offered to set up temporary gages at locations where gages were damaged or destroyed. They also offered to make stream flow measurements at key locations. There was not a need for any temporary gages, but the USGS did make several flow measurements that will provide valuable information for documenting the flood.

Why did it happen?
-The Harpeth River experienced what appears to be a greater than 500-year event that overtopped the gage equipment by several feet.
-There is not a viable location for the Bledsoe Creek gage that does not place it in harm's way for extreme events.
-The Old Hickory tailwater water quality monitor is located on the lower lock wall and is vulnerable to greater than 100-year events.
-The Cheatham tailwater water quality monitor was located on the left descending bank and was also susceptible to damage from high flows.

How can we do it better and who has the lead to fix it?
-LRN WM recently completed a thorough evaluation of its gaging program with respect to establishment of the Cumberland River Basin CWMS application. This indicates that individual gage locations need to be evaluated with respect to inundation potential.
-LRN is entering into a formal partnership with the Kentucky and Tennessee USGS offices through participation in the Cooperative Stream Gaging Program. LRN has a gage transition plan that supports this action.

DRAFT

Category: Water Management
27. Issue: Sustain the ability to operate projects under extreme conditions.

What was planned?
-Operate the Cumberland Basin reservoir system using the water control manuals.

What actually happened?
-The magnitude, duration, and location of the rainfall were such that flood stages along the Cumberland River were pushed to new record levels during the event.
-Information contained in the water control manuals did not cover the full range of operations required to respond to this record rainfall event.
-LRN Water Managers were working with incomplete data sets, access to the District Office was difficult, and multiple demands were placed on staff to provide information and brief officials, both in-house and external. Reservoir system operations were further hampered by a prolonged network outage that occurred on Sunday. The three LRN WM team members making the operational decisions each had thirty plus years of direct water management experience and had been through multiple high water events in the Cumberland River Basin. Their experience of knowing when and how to deviate from direct application of the water control manuals can be credited with preventing additional damages and perhaps saving several lives in the basin.
-A chronological analysis of water control actions taken during this event is presented below. Where appropriate, an explanation of deviation from operations detailed in the water control manuals is included.
-In order to evaluate the impacts of water control operations that were outside of the guidance presented in the water control manuals, a detailed analysis using sophisticated hydrology and hydraulic modeling was required. This analysis required taking existing model components and combining them into a system model. In turn, this model was calibrated to the May 2010 flood event. Given limitations with respect to time and resources, a preliminary analysis of actual and water control manual guidelines were completed using a detailed Hydrologic Engineering Centers River System Analysis (HEC-RAS) model. In this analysis, the modeler was able to employ an iterative approach to project operations to meet water control guidelines and reduce downstream impacts. However, during the actual event, Corps water managers were not afforded this opportunity. They were placed in the position of making multiple time-sensitive decisions spaced across multiple projects within the Cumberland Basin and to do so without the availability of a detailed model. The results of the HEC-RAS model evaluation are included where appropriate in the following sections of this report.

29-30 April 2010: Thursday and Friday
-Based on the NWS rainfall forecast (Quantitative Precipitation Forecast (QPF) products) indicating significant rainfall (3-5 inches within the Cumberland River Basin) starting on Saturday, May 1, LRN WM made the decision to pull some water out of the main-stem projects in advance of the storm. The lake levels at Cordell Hull and Old Hickory were lowered approximately 0.5 feet. The Cheatham pool was lowered about 1.0 foot. This was not completed until Saturday, May 1 prior to the initial heavy rainfall. These actions were taken to better position the reservoir system to be able to manage for the forecasted rainfall totals.

- This is a typical operation to manipulate lake levels within normal operating ranges. It is better characterized as an adjustment as opposed to a significant change.

DRAFT

1 May 2010: Saturday

-1000 hours - The hydropower unit at J. Percy Priest and one of three units at Center Hill were each brought on-line at 1000 hours and run continuously for the remainder of the day. These decisions were based on observation of the radar rainfall amounts and the near certainty that both the Stones River and Caney Fork watersheds were going to receive excessive rainfall.

- These are typical same day adjustments to the hydropower generation schedule needed to react to changing hydrologic conditions. The J. Percy Priest hydropower unit was not scheduled to be run on this date. It was brought on-line at 1000 hours. Center Hill had eight hours of generation scheduled for May 1. Once one unit was brought on-line at 1000 hours it was left on for the remainder of the day. The action at Center Hill was taken to conserve flood control storage and manage the lake level in accordance with the Interim Risk Reduction Measure (IRRM) pool restriction for a Dam Safety Action Classification (DSAC) I dam. The additional flow did not pose a threat to Carthage, TN, the immediate downstream damage center.
- Wolf Creek was operating four hydropower units around the clock in response to rain, which fell about one week prior to this event. The pool elevation at this time was 682.92. Wolf Creek operates with a DSAC I IRRM pool restriction target elevation of 680 ft. The lake level at Dale Hollow was elevation 650.16. One hydropower unit was running around the clock for lake level management.
- Section 2.4.5 of the Old Hickory water control manual states "The size of the surcharge storage pool was derived considering flows expected while the storage reservoirs were being emptied. It was not intended to also compensate for heavy local runoff simultaneous with peak releases from Wolf Creek, Dale Hollow, and Center Hill."

1200 hours – Spillway discharges are initiated at Old Hickory.

- The spillway discharge was increased at a rate of approximately 5,000 cfs/hr in accordance with the water control manual until a total flow of 75,000 cfs was reached.
- LRN WM made the decision to not apply the Nashville crop season control limit of 54,000 cfs. According to the water control manuals, crop season is generally understood to be from April 15 through December 15; however, these dates may be adjusted depending on actual field conditions. Flood season is designated as anytime other than crop season. Since the area had experienced an average of two inches of rainfall approximately a week before, and with the limited agricultural activity observed in this reach of the river, the flood control flow of 90,000 cfs was selected for use. Therefore, by going to 75,000 cfs out of Old Hickory, an additional capacity of 15,000 cfs was reserved for a combination of J. Percy Priest releases and local runoff from the 275 mi^2 of local uncontrolled runoff between Old Hickory Dam and Nashville. The objective of this course of action was to keep the Cumberland River from reaching flood stage at Nashville.

1730 hours – Spillway releases are initiated at Cordell Hull.

- The spillway discharge was increased at a rate of approximately 5,000 cfs/hr in accordance with the water control manual until a total flow of 50,000 cfs was reached. When the pool reached elevation 505.25, the flow was increased to 60,000 cfs. The control flow of 72,000 cfs for flood season was used for Carthage. Therefore, by going to 60,000 cfs out of Cordell Hull, an additional capacity of 12,000 cfs was reserved for a combination of Center Hill releases and local runoff from the 420 mi^2 of local

DRAFT

uncontrolled runoff between Cordell Hull Dam and Carthage. This action was taken in an effort to keep the Cumberland River from reaching flood stage at Carthage.

- When the Cordell Hull discharge reached 60,000 cfs at 2400 hours on Saturday, May 1, the discharge was held steady in an effort to limit the volume of water entering Old Hickory Lake.
- A total of three spillway gate changes were made on May 1.

1900 hours – Cheatham goes to free flow.

- The Cheatham Lock and Dam was designed to allow overtopping of the lock and spillway gate section without threat of failure of the dam. The Power Plant is at a higher elevation and does not become inundated during extremely high flows such as those observed during this event. When the river flow past Cheatham exceeds the flow that can be regulated by the seven available spillway gates, the gates are lifted out of the water and the river goes to what is referred to as free flow. In this condition there can be very little difference (less than 1 ft) between headwater and tailwater elevations.

2300 hours – 75,000 cfs outflow reached at Old Hickory

- This outflow was maintained to allow time for excessive local flows to recede downstream.
- A total of nine spillway gate increases were used to reach 75,000 cfs on May 1**.**

2 May 2010: Sunday

0930 hours – The district office lost network access and no real time data was available until it was restored at 2005 hours. The phones were still working and project data was available when projects were called.

1000 hours –Releases from Old Hickory had been managed overnight to hold Nashville to the control flow limit and keep the river below flood stage. As a result the headwater elevation at Old Hickory had risen to elevation 447.75 at 0600 hours. Intense storms that started at around 0700 hours on May 2 had already dumped in excess of three inches of rainfall onto saturated ground in the Nashville and Old Hickory area by 1000 hours. A series of spillway gate increases were made at Old Hickory as LRN water managers reacted to rapidly increasing lake levels resulting from runoff from the local uncontrolled basin to Old Hickory Lake.

- The Old Hickory water control manual limits spillway gate increases to 5,000 cfs/hr. This rate of increase is not to be exceeded until the headwater elevation reaches the top of the surcharge pool. At that point the water control manual states that the discharge is increased as necessary to maintain the water surface at the top of the flood surcharge pool, elevation 450.0. It quickly became apparent that the Old Hickory lake level could not be adequately managed by adhering to this requirement. Project releases were managed in as controlled a method as possible. However, spillway discharge increases as frequently as every 15 minutes and some by as much as 10,000 cfs were necessary to prevent the upstream lock wall from being overtopped. By following this course of action a one step increase in discharge of a magnitude to match project inflows was avoided. This allowed LRN water managers to reduce the rate of rise in the Old Hickory pool by continuing to maintain controlled releases from the project. Ultimately, by maintaining control at Old Hickory Dam, a reduction of downstream flood impacts was realized.
- Figure 1 presents stage hydrographs and flow at the Nashville gage for two modeled scenarios. The red lines are a model representation of the actual operations. The blue

DRAFT

curves represent the scenario where strict adherence to the water control manuals was maintained. A significant divergence can be observed in the two sets of curves beginning late Saturday night, May 1, and extending through Monday (May 3). If LRN water managers had made the extreme spillway gate increases necessary to prevent the Old Hickory Lake level from exceeding the top of the surcharge storage pool, elevation 450.0, that action would have resulted in Nashville area flooding that would have started several hours earlier and would have been characterized by a more aggressive rate of rise than what was observed during the event. The difference in ultimate flood crest between the two scenarios was not significantly different.

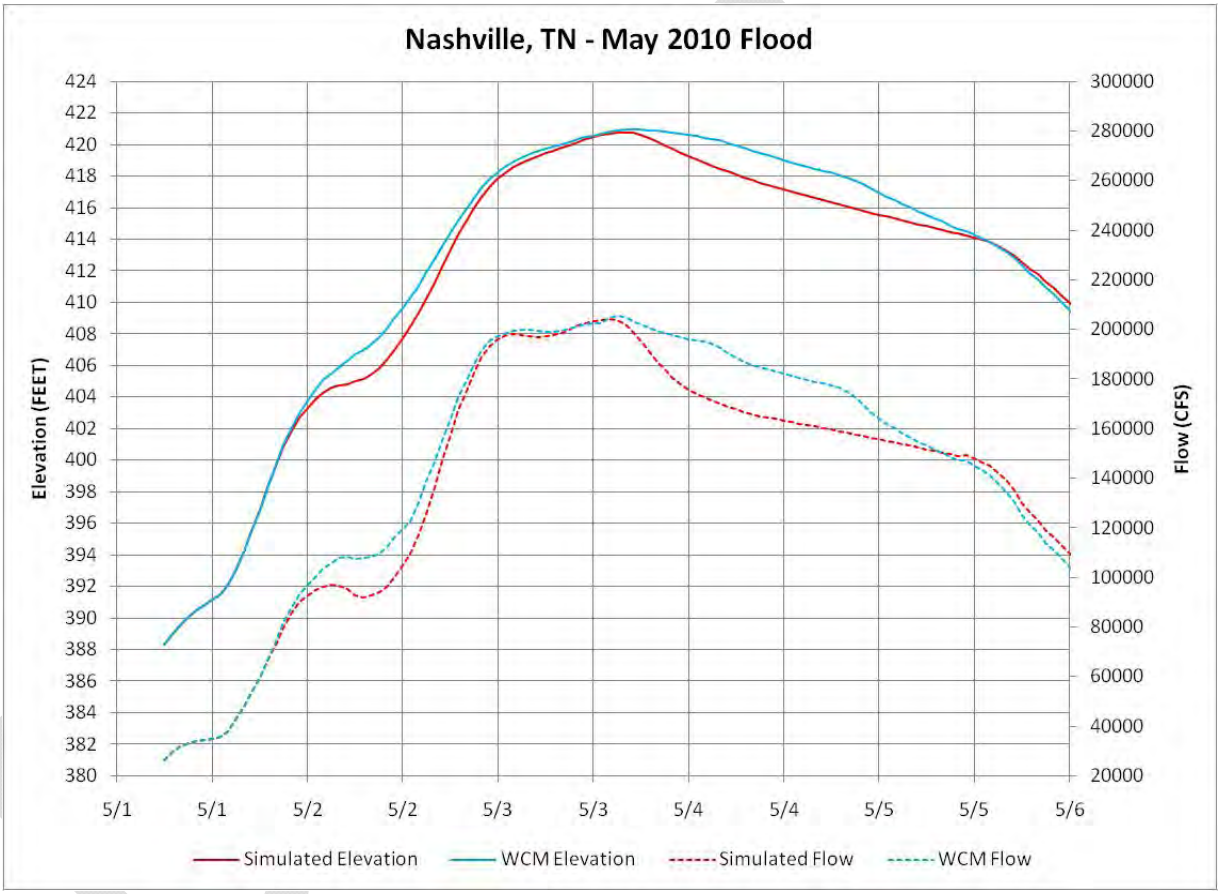

Figure 1 - Comparison of Stage Hydrographs and Flow Rates for Simulated.

- Operations and Water Control Manual Operations at Nashville. The water control manual states that "When the headwater rises to elevation 450, the 5,000 cfs per hour limitation will no longer apply and releases may be increased as necessary to prevent any further rises in the headwater." Despite the numerous spillway gate increases employed, the Old Hickory lake level exceeded the top of the surcharge pool, elevation 450, and by 1400 hours had reached a new pool of record of elevation 451.45. At this point, water was only 6.6 inches from flowing over the upstream lock wall, and threatening continued operation of the project. If the powerhouse had been flooded, plant staff would have been required to pull the gates out of the water and abandon the project. An analysis of

this scenario indicates that if that had occurred the stage would have been approximately four feet higher at the Nashville gage.

- During the event, one of the six spillway gates was out of service for scheduled maintenance. The maintenance being done on the gate required the bulkhead to be put in place and a great deal of equipment and scaffolding to be in the immediate area which prevented it from being put back in service. Ultimately, following a total of 19 spillway gate increases, the five available spillway gates reached a maximum opening of 34 feet at 1700 hours. The corresponding discharge at this gate setting was estimated to be 212,260 cfs. Once the headwater elevation exceeded 450 and the gate opening exceeded 25 feet, the spillway gate rating tables were no longer applicable. To address this issue during the event, LRN water managers performed an analysis and provided the Old Hickory Power Plant operators with updated rating tables to cover the full range of use. The maximum gate opening for Old Hickory is 42 feet.
- If an even more aggressive spillway discharge pattern had been followed in order to keep the pool below elevation 450, much larger releases from Old Hickory would have been required. These higher flows would have been in the river in the Nashville area at the same time as the peak local runoff. This would have resulted in a more aggressive rate of rise and pushed the river to flood stage much sooner (several hours) in the Nashville area resulting in very limited warning time for homes and businesses.
- The Old Hickory spillway gate change implemented at 1000 hours resulted in a total project discharge of 90,000 cfs. At this time, instead of stopping all discharge from J. Percy Priest as detailed in the water control manual, the decision was made to reserve the remaining storage available in J. Percy Priest for when the flood crest approached Nashville. Given the existing hydrologic conditions, LRN water managers knew that the crest was still many hours away, and that the storage in J. Percy Priest would be much more valuable later in the event.

1000 hours – Given the regional nature of this event and ambient conditions on the lower Ohio River, LRD WM had already assumed control of the releases from Barkley and Kentucky. Through a series of discussions between Corps and TVA water managers, a plan was developed that resulted in a series of spillway gate increases being started at 1000 hours.

- The Barkley water control manual limits spillway gate increases to 5,000 cfs/hr and no more than 40,000 cfs in one day. Given the magnitude of this event and the corresponding water control measures, it was clear that this event could not be properly managed within the guidelines of the water control manual. By midnight on 2 May, the discharge had been increased by 114,400 cfs to 156,500 cfs and several of the increases were on the order of 10,000 cfs/hr. This was done to preserve flood storage in the Barkley and Kentucky pools for later in the event. This plan also addressed a flood crest moving down the Ohio River from rainfall that had occurred several days earlier in the Ohio Basin.

2100 hours – Stopped generation J. Percy Priest and made the first spillway gate reduction at Old Hickory. These actions were taken to manage the flood crest at the Nashville that was forecast at the time to occur at 0100 hours on May 3.

- The reduction at J. Percy Priest was based on the travel time from J. Percy Priest Dam to the Nashville area. It was timed to reduce the flood crest through Nashville.
- A series of spillway gate reductions were implemented at Old Hickory starting at 2100 hours. Again, this was designed to reduce the flood crest through Nashville. These cuts

DRAFT

were initiated when the Old Hickory lake level was still above the top of the surcharge pool. This is best characterized as an extraordinary measure in order to attempt to utilize every bit of possible storage in an effort to protect Nashville. Close attention was paid to the lake level in Old Hickory to avoid a lake level greater than the previous crest. By midnight, Old Hickory releases had been reduced from a peak of 212,260 cfs down to 193,400 cfs. Although this operation was outside the guidelines in the water control manual, if the manual would have been strictly followed, more water would have been put onto Nashville by evacuating surcharge storage from Old Hickory. Figure 1 above also covers this water control action. As noted in this plot the stage hydrograph for Nashville would have been somewhat higher for the water control manual operation than for the water control operations that were carried out during the event. However, for the last several hours on Sunday and the early morning hours on Monday the differences are fairly small.

- A total of nineteen spillway gate increases and three decreases were made at Old Hickory on May 2.

2100 hours, 2200 hours – LRN coordinated operations at Center Hill and Cordell Hull to provide flood control benefits for Carthage, TN. Hydropower generation at Center Hill was stopped at 2100 hours in anticipation of Cordell Hull discharges being increased above the control flow limit of 72,000 cfs at Carthage. At 2200 hours, following heavy rainfall in the Cordell Hull watershed, a series of spillway gate increases were required to manage the Cordell Hull lake level.

- Since control flow at Carthage could not be maintained while holding the Cordell Hull headwater elevation within the power pool, the water control manual states that the surcharge storage is to be utilized. Until 1500 hours, the Cordell pool was holding steady at control flow while utilizing only one foot of surcharge storage. Once the rain arrived in the Cordell Hull basin, it continued to be intense and slow moving. The water control manual states that if the headwater is rising faster than 0.15 feet per hour, Cordell Hull releases are to be increased and the Carthage control flow may be exceeded, but the increase is limited to 5,000 cfs per hour until the surcharge storage is used. It quickly became apparent that the Cordell Hull lake level could not be properly managed by adhering to this requirement. Project releases were managed in as controlled a method as possible. However, spillway discharge increases as frequently as every 30 minutes and some by as much as 10,000 cfs were necessary to prevent the upstream lock gate from being overtopped. Since the water control manual states that once the top of the surcharge pool, elevation 508, is reached, then the discharge is increased as necessary at that time to maintain the water surface at that level. By allowing it to go slightly higher and increasing faster, control of the structure was maintained and sudden, significantly higher discharges were avoided, thus reducing flood impacts downstream. As noted in Figure 2 the differences in stage and flow at Carthage between the two operational scenarios evaluated with the calibrated HEC-RAS model, actual operations and water control manual operations, are not significant. This can be attributed to how quickly the Cordell Hull lake level responded to uncontrolled runoff from the 1,372 mi^2 local drainage area above Cordell Hull Dam. The timing and magnitude of spillway gate openings was quite consistent between the two scenarios.
- The water control actions at Cordell Hull that began late on May 2 continued through the night.

DRAFT

- A total of seven spillway gate increases were made at Cordell Hull on May 2.

2300 hours, 2400 hours - Hydropower generation at Dale Hollow was stopped at 2300 hours. Hydropower generation at Wolf Creek was first reduced at 2300 hours and subsequently stopped at 2400 hours. These actions were taken in accordance with the system flood control operation to store water to reduce flows downstream during the crest.

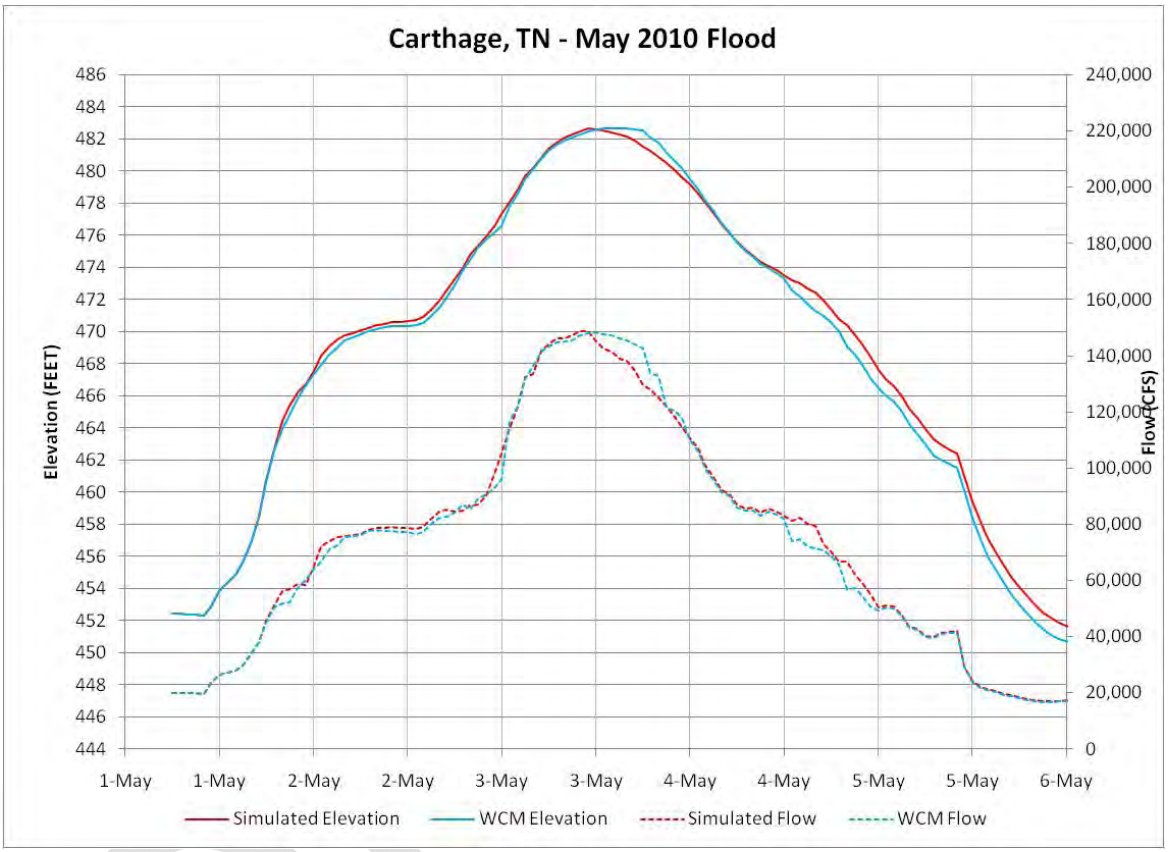

Figure 2 - Comparison of Stage Hydrographs and Flow Rates for Simulated Operations and Water Control Manual Operations at Carthage

3 May 2010: Monday

0000 hours - 0615 hours - Old Hickory makes additional spillway gate reductions at 0000 hours and 0100 hours; however, by 0300 hours the inflows to Old Hickory originating from large discharges at Cordell Hull and local uncontrolled runoff had pushed the Old Hickory pool up to elevation 451.25. In order to slow the rise in the Old Hickory lake level, spillway gate increases were necessary at 0300 hours, 0400 hours, and again at 0615 hours.

- Collectively, these three gate openings increased the Old Hickory discharge by about 15,000 cfs to a total of approximately 197,000 cfs. This release setting was held steady until 1300 hours when a series of reductions were initiated. This action recovered a small volume of storage at Old Hickory that could be applied later when the crest approached Nashville.

0000 hours -0500 hours – Cordell Hull continued to make spillway gate increases as the lake level responded to local uncontrolled runoff. The maximum gate opening of 16 feet for this event was reached at 0450 hours. Soon after reaching this maximum gate opening the Cordell Hull lake level started to decrease. The discharge was held constant until the pool fell to elevation 507.80.

- Despite the series of spillway gate increases that had started the previous day to match the rise in inflows, Cordell Hull reached a new pool of record of elevation 508.33 at 0500 hours. At this elevation, Cordell Hull was only 2.0 inches from overtopping the upstream lock gate.

0600 hours – A flood crest of 37.62 is observed at the Celina gauge.

0715 hours – The J. Percy Priest hydropower unit was brought back on line.

- The J. Percy Priest headwater elevation was forecasted to go above 504.5 in the next several hours. When the lake level reaches elevation 504.5 the spillway gates have to be operated to prevent overtopping the gates. LRN water managers made the decision to bring hydropower generation back on-line and preserve the remaining storage in J. Percy Priest for the crest that appeared to be several hours from reaching Nashville.

1100 hours – Cordell Hull pool level drops below the elevation 508.0 surcharge storage threshold, allowing spillway gate reductions to be made. Flow reductions were made in an effort to protect Carthage, TN; the damage center located a short distance downstream of Cordell Hull Dam.

- LRN water managers issued the instruction to the Cordell Hull operators to continue to make spillway gate reductions in an aggressive fashion as long as they could do so without causing the pool level to go back above elevation 508.0.
- The Cordell Hull water control manual states once the lake elevation peaks within the surcharge storage pool that the maximum discharge reached should be maintained until the headwater level recedes back to the top of the power pool (elevation 504.5).
- A total of 11 spillway gate reductions were made between 1100 hours and 2300 hours on May 3 as the project inflows continued to fall throughout the day.
- A total of six spillway gate increases and eleven decreases were made at Cordell Hull on May 3.

1200 hours – Initiated spillway gate increases at Barkley.

- LRD WM was directing operations at Barkley and Kentucky Dams. Earlier in the day the Barkley discharge had been increased to 260,000 cfs and then held steady for three hours. At 1200 hours, a series of four 10,000 cfs/hr spillway gate increases were initiated to take the total release to 300,000 cfs. These 10,000 cfs/hr increases exceeded the maximum guideline of 5,000 cfs/hr identified in the Barkley water control manual. The 300,000 cfs flow represented a new record discharge for the Barkley project.
- This action was taken to conserve storage in the Barkley and Kentucky pools for a flood crest that was coming down the Ohio River.
- When these flow increases were made the Barkley tailwater rose accordingly, resulting in the flooding of several homes downstream of the dam.
- The Barkley water control manual does not address notification of downstream interests when significant flow increases are made. The practice has always been that LRN WM contacts the Barkley power plant operator and issues instructions on how and when spillway gate changes are to be made. In turn, the operator alerts both Barkley Lock and Lock &Dam (L&D) 52 of the upcoming change. Ultimately, the Barkley Resource

DRAFT

Manager's Office typically coordinates with local emergency management offices on flow increases; however, this procedure is not a formalized process. The Barkley Resource Manager is very familiar with the river and will call if they sense a change. LRN will develop a formalized plan to alert downstream emergency managers (in addition to the ongoing process through the NWS) similar to what is in place with the lock for timely communication of changes in discharge.

1200 hours – A flood crest of 46.06 is observed at the Carthage gauge.

1300 hours - Spillway reductions are initiated at Old Hickory in an effort to reduce the flood crest through Nashville. There was a particular emphasis placed on preventing inundation of Nashville's Omohundro Water Treatment Plant, due to the fact that the other Nashville water treatment plant (K. R. Harrington located at the mouth of the Stones River) had been flooded earlier in the event. Thanks to the intensive sand bagging efforts, using sand bags furnished by LRN, the City of Nashville was able to prevent the loss of their potable water supply for an extended period of time.

- Between 1300 hours and 1730 hours a total of spillway gate reductions were made at Old Hickory. These reductions reduced the flow out of Old Hickory from 196,500 cfs at 1300 hours to 144,200 cfs at 1900 hours, or a total flow reduction of around 52,000 cfs.
- The Old Hickory lake level was closely monitored by field and water management personnel during and following these flow reductions. The pool was allowed to rise back above the top of the surcharge storage pool. This prevented additional water from being placed on top of the crest as it entered the Nashville area. A break in weather conditions provided an opportunity for this action to be taken. The rain had ended and significant flow reductions had been made at the upstream projects as the flood crest had already moved through.
- The Old Hickory water control manual states once the lake elevation peaks within the surcharge storage pool that the maximum discharge reached should be maintained until the headwater level recedes back to the top of the power pool (elevation 445.0).
- A total of three spillway gate increases and eight decreases were made at Old Hickory on May 3. No additional spillway gate changes were required until Wednesday, May 5.

1500 hours – A special request was made by TVA to address a power transmission line problem associated with Dale Hollow being off-line. The remedy for this problem was to bring one hydropower unit back on line. LRN WM reviewed the request, and determined that since Celina had crested and local flows were receding, this could be done without any downstream impacts. One turbine was placed in service at 1500 hours.

- This action was consistent with guidance in water control manuals with respect to recovering flood control storage after the flood crest has passed.

1800 hours – A flood crest of 51.86 is observed at the Nashville gauge.

1900 hours - Spillway reductions initiated at Barkley in response to downstream flooding.

- Two spillway gate reductions were made to reduce the Barkley outflow to around 280,000 cfs. This was done in response to flooding of several homes in an area a short distance downstream of Barkley Dam. This flow was maintained through the end of the day.

2200 hours – Cheatham reaches a new pool of record of elevation 404.15.

2330 hours – LRN performed surcharge operation at J. Percy Priest.

- Old Hickory Hydropower personnel were dispatched to J. Percy Priest Dam to carry out a surcharge storage operation. They were instructed to continuously track the J. Percy

DRAFT

Priest lake elevation and when the pool reached the top of gates they were to open each of the gates 0.5 foot. This was done to limit releases as much as possible to prevent an increase in water levels above the observed crest.

- The J. Percy Priest spillway gates were initially opened at 2330 hours. However, one of the gates did not function properly. The field staff opened one of the gates to 1.0 foot and two gates to 0.5 ft. An Old Hickory power plant electrician was called in. He quickly diagnosed the problem with the gate and made the necessary repair. This quick action prevented the non-functioning gate from being overtopped. At 2400 hours all four gates were opened to 0.5 foot. This resulted in a project release of 7,000 cfs.
- With the J. Percy Priest headwater elevation at 504.5, the water control manual specifies a total project release of 17,000 cfs. This is generally considered to be the channel capacity for the Stones River below J. Percy Priest. However, given how high the Cumberland River was at the time, a release of 17,000 cfs would have induced additional flooding along the Stones River and would have likely increased the Nashville stage higher than the earlier crest. The HEC-RAS model results for the Nashville gage presented above in Figure 1 are somewhat inconclusive in that the stage difference observed at Nashville cannot be specifically tied to flow reductions at Old Hickory or delaying spillway operations at J. Percy Priest. Rather; for the period starting Monday (May 3) evening and extending through the middle of the day on Wednesday (May 5), the combination of water control actions executed by LRN water managers at these two projects resulted in significant stage reductions (~ 2 feet for much of this period) at Nashville when compared to the water control manual operational scenario modeled with HEC-RAS. Given more time and resources, a sensitivity analysis could be performed to quantify the magnitude of the stage reductions attributed to each project.

4 May 2010: Tuesday

0000 hours – Two hydropower units were brought on-line at Wolf Creek and one at Center Hill. A third Wolf Creek unit was brought on-line at 1200 hours.

- This is in accordance with the water control manuals that state, "After the flood crest has passed, utilized flood control storage is evacuated as fast as practical to prepare for future potential floods."

0000 hours - 0500 hours – Spillway gate reductions at Cordell Hull.

- As the Cordell Hull local runoff receded, a series of spillway gate reductions were made to reach control flow (0500 hours). LRN WM instructed Cordell to hold control flow until the pool fell to within two feet of guide curve (1600 hours). At that point a spillway gate cut scheme was developed to allow a smooth transition to normal operating levels.
- All gates at Cordell Hull were closed at 0600 hours on the next day.

0400 hours -1600 hours – Submergence problems with the spillway gates at Barkley.

- When the Barkley project experiences extremely high tailwater elevations like it did on this date a submergence problem is encountered with operation of the spillway gates. The Barkley spillway gates must be clear of the water on the tailwater side when in operation or they will be subject to extreme vibration. Therefore, a gate must be either closed or open high enough to clear the tailwater. As a result, operators and water managers are sometimes unable to produce the desired flow and must decide on either a flow lower than the target or higher. The differences can be fairly significant since extremely large gate openings are required at the individual gates.

DRAFT

- The Barkley power plant operators were forced to make a series of gate changes between 0500 hours and 0805 hours to address submergence problems. During high discharges from Barkley Dam, when the tailwater elevation becomes high, the spillway gates can become partially submerged. This results in intense vibration that threatens the structural integrity of the spillway section. Therefore, adjustments to the gate arrangement must be made quickly to alleviate this situation. The solution to this problem requires that individual gates are either raised to very large gate openings or they remain closed. As a result, rather than opening many or all gates to a moderate gate opening, a few gates are opened to very large gate openings. The final result is that project outflows are often either higher or lower than the target release due to the limitations on spillway gate use. During this period the spillway gate settings resulted in project releases that were higher than the objective.
- Barkley set a new discharge record of 303,200 cfs at 0800 hours.
- At 0800 hours per direction from LRD WM, LRN WM directed Barkley to reduce project discharge to 240,000 cfs. Again, due to submergence the closest the operators could get to this target was 266,000 cfs by completely closing one gate.
- At 1600 hours per direction from LRD WM, LRN WM directed Barkley to close one additional spillway gate. This resulted in a project discharge of 230,000 cfs.

0700 hours – A flood crest of 62.58 feet is observed at the Clarksville gauge.
0800 hours – Spillway gate adjustment at J. Percy Priest.

- A surcharge operation at J. Percy Priest had been initiated at 2330 hours the previous day. By 0800 hours the lake level had risen to the point that a gate adjustment was required to prevent overtopping the gates. The gates were raised an additional 0.3 foot each to prevent water from sloshing over the gates. This increased the project release from 7,000 cfs to 8,600 cfs.

5 May 2010: Wednesday
0600 hours – All spillway gates at Cordell Hull are closed and the project is returned to normal operations.
0900 hours – A series of spillway gate reductions were initiated at Old Hickory as the inflow to the project steadily declined.

- A total of ten spillway gate reductions were made at Old Hickory on May 5.

1200 hours – Additional hydropower units were brought on-line at Wolf Creek, Dale Hollow, and Center Hill as the effort to recover reservoir storage continued.

- Wolf Creek – went from three units to five units at 1200 hours
- Dale Hollow – went from one to two units at 1200 hours
- Center Hill – went from one to two units at 1200 hours and from two to three units at 1400 hours.

6 May 2010: Thursday
0000 hours -1300 hours – Spillway gate reductions at Old Hickory continued throughout the day. Old Hickory was back within its normal operating range by the end of the day.
1000 hours – Continued to adjust project release schedules at the tributary projects to evacuate water from storage.

- Wolf Creek – opened two sluice gates at 1000 hours
- Center Hill – opened two sluice gates at 1230 hours

DRAFT

1000 hours – Ohio River Flood Control Operation

- Initiated a series of spillway gate reductions to reach a total flow of 150,000 cfs by 1900 hours. This was directed by LRD WM to support ongoing flood control operations for the lower Ohio River.

7 May 2010: Friday

0000- hours 2400 hours – No significant water management actions were required.

- Cordell Hull and Old Hickory had already returned to normal operating levels.
- The process of evacuating water from storage continued at Wolf Creek, Dale Hollow, Center Hill, and J. Percy Priest.
- Cheatham remained in free flow as it had been since Saturday, May 1 at 1900 hours.
- Releases at Barkley continued to follow the requirements of the ongoing Ohio River flood control operation.

1600 – Barkley reached a peak elevation for this event of 369.00. This is about 1.0 ft lower than the pool of record established during the May 1984 flood event.

8 May 2010: Saturday

0830 hours – The spillway gates were placed back in service at Cheatham. This action returned Cheatham to normal project operations.

1000 hours – Continued to adjust project release schedules at the tributary projects to evacuate water from storage.

- J. Percy Priest – increased spillway discharge by 1,000 cfs to a new total discharge of 9,100 cfs at 1000 hours
- J. Percy Priest – increased spillway discharge by an additional 1,000 cfs at 1100 hours. The revised total project discharge was now 10,100 cfs.

1000 hours -1200 hours – Reduced project discharge from 150,000 cfs to 120,000 cfs by applying three 10,000 cfs reductions.

- The 120,000 cfs discharge at Barkley was continued until May 17 when flows were further reduced to 70,000 cfs. On May 18 the flows were reduced again to 50,000 cfs.

<u>Why did it happen?</u>

-The Cumberland Basin was subjected to an epic rainfall and a flash flood event that started on May 1, 2010. A significant amount of the intense rainfall fell over the uncontrolled portion of the basin adjacent to the Cordell Hull, Old Hickory, and Cheatham projects. The two-day rainfall totals were in excess of 15 inches in many areas, and exceeded the 1,000-year rainfall event.

-This event generally outpaced the science in terms of being able to develop accurate, timely rainfall forecasts, model the hydrology, and develop well-timed flood crest forecasts.

-The event also outpaced the capability of the Cumberland Basin reservoir system to manage the event in a prescribed manner.

-The notification process for flow increases at Barkley, which in the past had worked adequately during moderate storm events, did not hold up to the rigors of a major flood.

-The network outage that occurred on Sunday, May 2 limited LRN WM's access to data during a critical period. The only access to this data was via internet service on cell phones and by calling the projects.

DRAFT

-Rating tables for spillway gates at Old Hickory were not extensive enough to cover the full range of gate openings required during the event.
-The water control manuals do not include slope storage tables for Cordell Hull, Old Hickory, and Cheatham. This made developing reasonable estimates of project inflows during the event problematic when slopes on individual projects of approximately 35 feet were observed.
-The current water control manuals for the Cumberland River Basin projects were last updated in 1998. The 1998 revisions were largely updates of manuals prepared when the projects were constructed which for several was in the 1950s.

How can we do it better and who has the lead to fix it?
-LRN will develop a notification process in the water control plans for the projects to pass critical information to emergency managers in a timely manner with clear roles and responsibilities defined. The process should include notification of the resource managers.
-LRN WM will update the project water control manuals to cover more extreme events and will include updated rating curves and slope storage tables for the main river projects.
-LRN WM will investigate issues within the water control manuals that were not robust enough to deal with the magnitude of this flood event. Those issues required LRN water managers to deviate from guidance in the manuals in order to reduce flood impacts at particular locations.
Cordell Hull

- The hourly rate of change limit of 5,000 cfs/hr was not sufficient to manage the project inflows during this event. Consideration should be given to raising the allowable increase to better position the project to manage surcharge storage without imposing sudden flow increases on Carthage.
- The current water control manual states that once the surcharge storage upper limit of elevation 508.0 is reached, a one step flow increase large enough to pass inflow (and prevent any further pool rise) should be implemented. A sudden discharge increase of the magnitude necessary for extreme flow events would result in a rapid rise downstream, including the Carthage damage center.
- The water control manual states that the maximum discharge should be maintained until the Cordell Hull Lake level gets back to near normal operating range. This operational scheme runs the risk of putting the maximum discharge on the crest when flows could be reduced by employing available surcharge storage.

Old Hickory

- The hourly rate of change limit of 5,000 cfs/hr was not sufficient to manage the project inflows during this event. Consideration should be given to raising the allowable increase to better position the project to manage surcharge storage without imposing sudden flow increases on downstream areas including Pennington Bend and Nashville.
- Existing guidance in the water control manual correlates discharge increases to prescribed rates of rise in the surcharge storage pool. This policy does not always support utilization of available surcharge storage at the most opportune time to maximize downstream flood control benefits. Need to evaluate and update the water control manual.
- The current water control manual states that once the surcharge storage upper limit of elevation 450.0 is reached, a one step flow increase large enough to pass inflow (and prevent any further pool rise) should be implemented. A sudden discharge increase of the magnitude necessary for extreme flow events would result in a rapid rise downstream

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including the Nashville damage center. Need to evaluate and update the water control manual.

- The water control manual states that the maximum discharge should be maintained until the Old Hickory Lake level gets back to near normal operating range. This operational scheme runs the risk of putting the maximum discharge on the crest when flows could be reduced by employing available surcharge storage. Need to evaluate and update the water control manual.

J. Percy Priest

- The J. Percy Priest water control manual states "If the Nashville flow is forecasted to exceed the maximum desired level, releases from J. Percy Priest are curtailed, and flood control storage utilized in a manner that will reduce the flood crest at Nashville as much as practical." Under scenarios like the May 2010 flood event, this requirement forces flood storage to be used early in an event rather than save it for use at the time of the crest.
- Existing guidance for operation of J. Percy Priest using the Emergency Operations Schedule in the water control manual does not accommodate (under all flood related scenarios) reducing the discharge from the project at critical times as flood crests approach Nashville. This flood control project provides the last opportunity to reduce the flood crest at the Nashville damage center. However, when the lake level is within the surcharge pool (greater than elevation 504.5) the Emergency Operations Schedule requires a minimum of 17,000 cfs being released from the project. This goes against the effort to utilize all available flood control in an effort to reduce downstream flood damages.
- The Emergency Operations Schedule requires that if the rate of rise in the headwater at specific headwater ranges reaches (both above and below elevation 504.5) a prescribed amount, then the pre-determined releases should be made. For the May 2010 event, this requirement would have resulted in a spillway gate increase of approximately 11,000 cfs over what was observed. Given the timing of when this guidance would have applied, the additional water would have increased the flood crest in Nashville. The specifics of how much higher the crest would have been at the Nashville gage will be determined by ongoing HEC-RAS modeling.

Barkley

- The hourly rate of change limit of 5,000 cfs/hr and the corresponding 40,000 cfs daily discharge increase were not sufficient to manage the project inflows during this event. Consideration should be given to raising the allowable discharge increase, both the hourly rate of rise and the daily limit, to better position the project to manage flood control storage in support of flood control operations for the Ohio and Mississippi Rivers.

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