Appendix D

Hydrology and Hydraulics

APPENDIX D

HYDROLOGIC AND HYDRAULIC REPORT

BEAVER LAKE

WATER SUPPLY STORAGE REALLOCATION

BENTON-WASHINGTON REGIONAL PUBLIC WATER AUTHORITY,

CARROLL-BOONE WATER DISTRICT,

AND

MADISON COUNTY RURAL WATER AUTHORITY

July 2017

CESWL-EC-H

BEAVER LAKE WATER SUPPLY STORAGE REALLOCATION

BENTON-WASHINGTON REGIONAL PUBLIC WATER AUTHORITY,

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HYDROLOGY AND HYDRAULIC REPORT

Table of Contents

LIST OF TABLES

LIST OF FIGURES

1. General

This study investigated the feasibility of storage reallocations in Beaver Lake for water supply that would provide an additional firm yield (or dependable yield) of 12 million gallons per day (MGD) for Benton-Washington Regional Public Water Authority (BWRPWA or Benton-Washington), 6 MGD for Carroll-Boone Water District (CBWD or Carroll-Boone), and 4 MGD for Madison County Regional Water District (MCRWD or Madison Country) for a total reallocation of 22 MGD. A comparative analysis of impacts, based on derived duration and frequency curves for reallocation plans versus existing or base conditions was performed for the White River Lakes (Beaver, Table Rock, Bull Shoals, Norfork and Greers Ferry), and also downstream, at White River control points (Calico Rock, Batesville, Newport, Augusta and Georgetown). In order to provide the requested water supply demands, the reallocation of currently authorized storage allocations was examined. The alternatives investigated are for the reallocation of storage from the conservation pool, the flood pool, or the inactive pool. The four plans explored in this study are henceforth referred to as: Base (existing), Conservation, Flood, and Inactive.

1.1 Scope of Work

Storage volumes for reallocations of the proposed water supply yields were determined. Hydrologic and hydraulic studies were performed to determine, frequency and duration for pool elevation, lake-outflow, river stage, and river discharge for each of the respective reallocation alternatives.

1.2 Beaver Lake Project Data

The main dam has a maximum height above the river bed of 228 feet and extends approximately 2,575 feet, of which 1,333 feet are concrete monoliths and 1,242 feet are earthen embankments. Beaver Lake has 7 gated spillway crest gates. Beaver Lake encompasses 28,370 acres at the top of the conservation pool (1,120.43 feet-National Geodetic Vertical Datum (NGVD)). Beaver's drainage basin is 1,186 square miles.

Beaver Lake's original 1960 design included water supply storage of 108,000 acre-feet (AF) for the Beaver Water District. Congress has allocated an additional 28,757 AF to Beaver Water District and 2,396 AF to Carroll-Boone Water District in 2006 from conservation storage. In 1977, Carroll Boone Water District contracted for 9,000 AF of conservation storage. In 1992, Madison Country Water acquired 3,882 AF of flood pool storage. Likewise, Benton-Washington Regional Public Water Authority contracted for 7,643 AF of flood pool storage in 1996. The total reallocations from flood pool storage has raised the top of conservation pool from 1,120.00 feet-NGVD by 0.43 feet to 1,120.43 feet, NGVD. With these flood pool reallocations, the storage capacity in the lake resulted in 286,880 AF for flood storage, 937,398 AF for conservation storage for water supply and hydropower and 726,800 AF of inactive storage for Commander approved emergency uses, including hydropower, fish habitat, recreation, water supply, and sediment storage. Total Project Storage is 1,911,500 AF (excluding surcharge storage – the volume above the top of flood pool). Table 1 summarizes the physical features of Beaver Lake.

Table 1: Beaver Lake Physical Features

Feature	Elevation(1)	Area (acres)	Storage Volume (ac-ft)	Cumulative Equivalent Runoff(2) (inches)
Top of dam	1142.00	36,260	2,358,700	13.10
Design pool	1137.00	34,290	2,182,500	9.94
Top of flood risk management pool	1130.00	31,700	1,951,500	7.05
Spillway crest	1093.00	19,690	1,007,200	4.48
Top of conservation pool	1120.43	28,371	1,664,198	3.15
Top of inactive pool	1077.00	15,540	726,800	0.96
Probable maximum drawdown	1075.00	15,540	726,850	
Sluice invert	937.90	237	1,279	
Streambed	914.00	0	0	
Total storage			2,182,500	
Flood risk management storage	1120.43-1130.00		286,880	
Conservation storage	1077.00-1120.43		937,398	
Inactive storage	914.00-1077.00		726,800	

(1) Feet, msl
(2) 1,186 sq mi of drainage area upstream of dam

1.3 Methods and Procedures

Basic hydrologic and hydraulic data for each alternative were computed in order to make necessary comparisons of each alternative to the Base plan. This data was used to develop annual pool elevation-frequency, pool elevation-duration, and annual lake discharge-frequency and lake discharge-duration for each of the White River Lakes. The data was also used to develop annual stage-frequency, stage-duration, annual discharge frequency and discharge-duration for the specified control points along the White River. The duration analysis was performed for an annual time period.

2. Hydrologic Analysis

2.1 General

The basic hydrologic data used for this study were developed using the White River Basin hydrologic routing model, RiverWare. The RiverWare White River Basin Model was developed by Little Rock District (SWL) as a replacement to the "Southwestern Division Reservoir Regulation Simulation Computer Model" (SUPER) model that had been used for years in region. The RiverWare model development carefully replicated the SUPER logic. All the issues found in the SUPER logic were corrected after RiverWare and SUPER matched. The primary advantages to RiverWare over SUPER are a convenient graphical interface and capability to automatically generate standard statistical reports for frequency and duration at key locations. This modeling approach has been used in the Little Rock District for all studies involving changes to the White River System since the 1970s. The RiverWare model reflects the current regulating plan and hydropower operations. A discussion of this computer model is provided in Appendix A-1. For this study, the Base condition includes the current allocations (congressional and discretionary). The base condition also utilizes the hydropower load operations developed by Southwestern Power Administration (SWPA) in August 2012. The model was calibrated to documented historical events at specific control points. The calibrated model was then used to simulate a period of record from 1 January 1940 through 31 December 2011 for the base condition and for each respective alternative reallocation (72 years of continuous record). The simulations were analyzed for water years (October to September) from 1941 through 2011 resulting in a continuous 70 year period of analysis daily flows, stages, and pool elevations for base conditions and for each respective alternative at the White River Lakes and specific control points along the White River. The RiverWare simulations for each alternative and the Base plan are listed in Table 2 along with a brief description for each simulation.

Table 2: Riverware Model Simulations

Alternative Plans	Riverware Run ID	Description
Base (No Action)	RW-W15X03	No Reallocation, Current Plan of Operation
Conservation	RW-W15X03-22mgd_BV	Reallocation From Conservation Pool
Flood	RW-W15X03+22mgd_BV	Reallocation From Flood Pool
Inactive	RW-W15X03-22mgd-From-DeadPool	Reallocation From Inactive Pool

2.2 Sediment in Beaver Lake

The White River above Beaver Lake has a relatively low sediment load, 0.0003 percent of average annual flow, and was estimated at the time of design to be about 350 AF per year. Sediment ranges have been obtained at nine (9) locations since the project was completed in 1966 (filling began in 1963). These ranges were obtained in 1965, 1977, and 1995. In those 30 years, only three (3) ranges indicate any measurable deposition. Although the lake is now over 51 years old, there have been no reported sediment problems. Storage in Beaver for sediment is not quantified but listed as one of the project purposes of the inactive pool. The inactive pool contains 726,850 AF of storage below elevation 1,077 ft-NGVD. The maximum probable drawdown is estimated to be 1,075 ft-NVGD, also the lowest rated pool for turbine operation, sometimes referred to as dead pool, is 696,200 AF. Assuming that the sediment accruing in Beaver Lake at the estimated rate of 350 AF per year; then, approximately 5.0 percent of the storage below elevation 1,075 ft-NGVD, or less than 5 percent of the total inactive pool storage would be filled in a 100 year period. Therefore, impacts from sediment deposition should not be an issue if reallocation of storage in the upper portion of the inactive pool for water supply was approved.

2.3 Spillway Adequacy for Probable Maximum Flood (PMF)

The Spillway Adequacy Study for Beaver Lake was done in 2010 and indicated a hydrologic deficiency due to overtopping by the Probable Maximum Flood (PMF). Routing the PMF through Beaver Lake showed no difference in maximum pool elevation based on the top of conservation pool at elevation 1,121.43 ft-NGVD (current base condition) versus 1,123.1 ft-NGVD (reallocation from flood pool).

2.4 White River Project – Firm Yield

Firm yield is the amount of water available for a specific use on a dependable basis during the life of the project. Model mini runs were used to determine the firm yield. The firm yield curves for the White River Basin were developed in 1997.

2.4.1 Project Inflow Assumptions0

The firm yield was established utilizing the inflow created only by the inflow through the drought of record. For Beaver Lake the drought of record was from 08 May 1961 until 08 Feb 1965. Notably, the worst drought was during construction and accounts for the slow first filling; the design manual used 1952 to 1956 as the drought of record.

2.4.2 Project Outflow Assumptions

1) The established reservoir leakage rate was considered.
2) There were no releases for power generation.

2.5 Yield-Storage Analysis

The yield at any location is dependent on the amount of inflow. The firm yield is determined based on the storage available during the critical low flow period less any required losses. The losses are primarily evaporation and leakage. Therefore, only changes to the available storage impact the yield at a specific location (Beaver Lake Dam). That is, for each change in storage the yield changes. For any increase in the project's storage the yield/storage ratio (YSR) is reduced thus requiring an increase in storage to maintain a given yield.

The conservation pool is the authorized storage for water supply and hydropower. Whenever the conservation pool storage is reallocated for Municipal and Industrial Water Supply, there is no change to the YSR. However, hydropower storage is reduced on a one to one ratio. When the conservation pool storage is increased by reallocation of other usable project storages, the YSR is decreased and the current water supply user's storage must be increased to maintain yield. The additional storage is called "dependable yield mitigation storage" or DYMS and only applies to the current water supply users. Hydropower storage remains the same and their yield is reduced.

The usable storages available for reallocation from Beaver is from the conservation storage (YSR remains the same), flood storage (YSR reduced), or inactive storage (YSR reduced).

2.5.1 Base Condition (No Action)

The current top of conservation pool, base condition, at elevation (EL) 1,120.43 ft-NGVD has incremental storage of 937,400 AF and a firm yield of 491.479 MGD (760.4 CFS). Additional RiverWare runs were made for incremental storage amounts in order to determine associated project storage yields. Figure 1 shows the firm yield for additional storage reallocated from flood pool. See Table.

2.5.2 Conservation Pool Reallocation

Reallocation of the conservation pool storage for the requested additional yields of 12 MGD for Benton-Washington, 6 MGD for Carroll-Boone, and 4 MGD for Madison County for a total reallocation of 22 MGD would require 41,963.236 AF (Benton-Washington: 22,889.038 AF, Carroll-Boone: 11,444.519 AF, and Madison: 7,629.679 AF). The reallocation would come entirely from the existing hydropower storage allocation and would reduce hydropower yield by 22 MGD, from 407.338 MGD to 385.338 MGD. Hydropower storage would be reduced to 735,120.556 AF. This reallocation of existing conservation storage would require no DYMS for existing water supply users since the yield/storage ratio would remain unchanged. The conservation storage of 937,400 AF has a firm yield of 491.479 MGD. See Table 3: Yield and Storage for Conservation Pool.

Table 3: Yield and Storage for Conservation Pool Reallocation

		Conservation Pool Reallocation			
		Existing		Proposed	
	Top of Conservation Pool (ft)	1120.43		1120.43	
	Yield/Storage Ratio (MGD/AF)	0.000524312		0.000524312	
	-	Yield MGD	Storage AF	Yield MGD	Storage AF
PROPOSED	**Madison County (Requested 2006)**	**-**	**-**	**4.000**	**7,629.036**
	Carroll Boone (Requested 2001)	**-**	**-**	**6.000**	**11,443.553**
	Benton-Washington (Requested 2000)	**-**	**-**	**12.000**	**22,887.107**
EXISTING	Carroll Boone Congressional (2006)	1.256	2,396.000	1.256	2,396.000
	Beaver Water District Congressional (2006)	15.078	28,757.000	15.078	28,757.000
	Benton-Washington (1996)	4.007	7,643.000	4.007	7,643.000
	Madison County (1992)	2.043	3,897.067	2.043	3,897.067
	Carroll Boone (1977)	4.746	9,051.226	4.746	9,051.226
	Beaver Water District (1960)	56.948	108,614.707	56.948	108,614.707
	Hydropower (1960)	407.338	776,898.826	385.338	734,939.131
	Non-allocable (due to round-off)	0.063	140.174	0.063	140.173
	TOTAL	491.479	937,398.000	491.479	937,398.000

2.5.3 Flood Pool Reallocation

Reallocation of storage for additional yields of 12 MGD for Benton-Washington, 6 MGD for Carroll-Boone, and 4 MGD for Madison County for a total reallocation of 22 MGD would require raising the top of conservation pool 1.67 ft from 1,120.43 ft-NGVD to 1,122.10 ft-NGVD and would require 42,982.346 AF of additional storage. Benton-Washington would require 23,416.664 AF, Carroll-Boone would require 11,708.332 AF, and Madison County would require 7,857.349 AF of contracted storage.

Increasing the conservation storage by raising the top of conservation pool would reduce the yield/storage ration and thus DYMS would be required for all existing water supply users except hydropower as their storage remains the same. The reduction in the yield storage ratio associated with raising the top of conservation pool would reduce the yield associated with the hydropower storage by 11.836 MGD, from the existing 407.338 MGD to 395.502 MGD.

Since Benton-Washington will be the first to contract for storage, they will have required DYMS amount of 2,249.079 AF to make the water supply contracts whole (Beaver Water District: 1,926.676 AF, previously allocated Carroll-Boone: 160.551 AF, Madison County 54.657 AF, and pervious allocations for Benton-Washington 107.195 AF). This would raising the top of conservation pool by 0.89 ft to EL 1,121.32 ft-NGVD. See Table 4: Yield and Storage for Flood Pool Reallocation.

Since Carroll-Boone will be the second to contract for storage, they will have required DYMS amount of 1,669.838 AF to make the water supply contracts whole (Beaver Water District: 1,251.805 AF, original Carroll-Boone: 104.3214 AF, Madison County 35.512 AF, and Benton-Washington 278.207 AF). This would raising the top of conservation pool by 0.47 ft to EL 1,121.79 ft-NGVD. See Table 4: Yield and Storage for Flood Pool Reallocation.

Finally, the Madison County purchase of DYMS will have required DYMS amount of 1,321.417 AF to make the water supply contracts whole (Beaver Water District: 932.383 AF, Carroll-Boone: 155.366 AF, previous Madison County 26.451 AF, and Benton-Washington 207.217 AF). This would raising the top of conservation pool by 0.31 ft to EL 1,122.10 ft-NGVD. Rounding the pool elevation up to the nearest hundredth of foot (1,122.10 ft-NGVD) actually results in 2.115 AF of non-allocated storage. See Table 4: Yield and Storage for Flood Pool Reallocation.

Table 4: Yield and Storage for Flood Pool Reallocation

	Existing		Proposed		Proposed Incremental DYMS (AF)			Total Proposed DYMS (AF)
Top of Conservation Pool (ft)	1,120.43		1,122.10		1,121.32	1,121.79	1,122.10	
Yield/Storage Ratio (MGD/AF)	0.000524313		0.000509078		0.000517	0.000512	0.000509	
	Yield (MGD)	Storage (AF)	Yield (MGD)	Storage (AF)	Benton-Washington	Carroll-Boone	Madison	
Madison County (Requested 2006)	-	-	**4.000**	**7,857.335**	-	-	-	-
Carroll Boone (Requested 2001)	-	-	**6.000**	**11,786.003**	-	-	**77.671**	**77.671**
Benton-Washington (Requested 2000)	-	-	**12.000**	**23,572.006**	-	**208.560**	**155.342**	**363.902**
Carroll Boone Congressional (2006)	1.256	2,396.000	1.256	2,467.701	**33.605**	**21.834**	**16.262**	**71.701**
Beaver Water District Congressional (2006)	15.078	28,757.000	15.078	29,617.557	**403.325**	**262.049**	**195.182**	**860.556**
Benton-Washington (1996)	4.007	7,643.000	4.007	7,871.718	**107.195**	**69.647**	**51.875**	**228.717**
Madison County (1992)	2.043	3,897.067	2.043	4,013.687	**54.657**	**35.512**	**26.451**	**116.620**
Carroll Boone (1977)	4.746	9,051.226	4.746	9,322.085	**126.946**	**82.480**	**61.433**	**270.859**
Beaver Water District (1960)	56.948	108,614.707	56.948	111,865.015	**1,523.351**	**989.756**	**737.201**	**3,250.308**
Hydropower (1960)	407.338	776,898.826	395.502	776,898.826	-	-	-	-
TOTAL	491.42	937,257.83	501.580	985,271.933	**2,249.079**	**1,669.838**	**1,321.417**	**5,240.334**

NOTE: Rounding up to pool elevation 1,122.10 ft results in 2.115 ac-ft of non-allocated storage.

2.5.4 Inactive Pool Reallocation

Reallocation of storage for additional yields of 12 MGD for Benton-Washington, 6 MGD for Carroll-Boone, and 4 MGD for Madison County for a total reallocation of 22 MGD would require lowering the bottom of conservation pool 3.05 ft from 1,077.00 ft-NGVD to 1,073.95 ft-NGVD and would require 42,513.274 AF of additional storage. Benton-Washington would require 23,089.669 AF, Carroll-Boone would require 11,630.816 AF, and Madison County would require 7,792.789 AF of contracted storage.

Increasing the conservation storage by lowering the bottom of conservation pool would reduce the yield/storage ration and thus DYMS would be required for all existing water supply users except hydropower as their storage remains the same. The reduction in the yield storage ratio associated with lowering the bottom of conservation pool would reduce the yield associated with the hydropower storage by 8.560 MGD, from the existing 407.388 MGD to 398.778 MGD.

Since Benton-Washington will be the first to contract for storage, they will have required DYMS amount of 1,419.257 AF to make the water supply contracts whole (Beaver Water District: 1,215.808 AF, original Carroll-Boone: 101.314 AF, Madison County 34.491 AF, and original Benton-Washington 67.644 AF). This would lower the bottom of conservation pool by 1.60 ft to EL 1,075.40 ft-NGVD. See Table 5: Yield and Storage for Inactive Pool Reallocation.

Since Carroll-Boone will be the second to contract for storage, they will have required DYMS amount of 1,376.826 AF to make the water supply contracts whole (Beaver Water District: 1,032.148 AF, original Carroll-Boone: 86.099 AF, Madison County 29.281 AF, and Benton-Washington 229.389 AF). This would lower the bottom of conservation pool by 0.86 ft to EL 1,074.54 ft-NGVD. See Table 5: Yield and Storage for Inactive Pool Reallocation.

Finally, the Madison County purchase of DYMS will have required DYMS amount of 993.004 AF to make the water supply contracts whole (Beaver Water District: 700.657 AF, original Carroll-Boone: 116.753 AF, Madison County 19.877 AF, and Benton-Washington 155.717 AF). This would lower the bottom of conservation pool by 0.59 ft to EL 1,073.95 ft-NGVD. Rounding the pool elevation down to the nearest hundredth of foot (1,073.95 ft-NGVD) actually results in 73.450 AF of non-allocated storage. See Table 5: Yield and Storage for Inactive Pool Reallocation.

Table 5: Yield and Storage for Inactive Pool Reallocation

	Existing		Proposed		Proposed Incremental DYMS (AF)			Total Proposed DYMS (AF)
Bottom of Conservation Pool (ft)	1,077.00		1,073.95		1,075.40	1,074.54	1,073.95	
Yield/Storage Ratio (MGD/AF)	0.000524313		0.000513295		0.000519713	0.000515871	0.000513295	
	Yield MGD	Storage AF	Yield MGD	Storage AF	Benton-Washington	Carroll-Boone	Madison	
Madison County (Requested 2006)	-	-	**4.000**	**7,792.789**	-	-	-	-
Carroll Boone (Requested 2001)	-	-	**6.000**	**11,689.183**	-	-	**58.367**	**58.367**
Benton-Washington (Requested 2000)	-	-	**12.000**	**23,378.366**	-	**171.963**	**116.734**	**288.697**
Carroll Boone Congressional (2006)	1.256	2,396.000	1.256	2,447.429	**21.206**	**18.002**	**12.221**	**51.429**
Beaver Water District Congressional (2006)	15.078	28,757.000	15.078	29,374.254	**254.514**	**216.067**	**146.674**	**617.255**
Benton-Washington (1996)	4.007	7,643.000	4.007	7,807.053	**67.644**	**57.426**	**38.983**	**164.053**
Madison County (1992)	2.043	3,897.067	2.043	3,980.716	**34.491**	**29.281**	**19.877**	**83.649**
Carroll Boone (1977)	4.746	9,051.226	4.746	9,245.506	**80.108**	**68.007**	**46.165**	**194.280**
Beaver Water District (1960)	56.948	108,614.707	56.948	110,946.066	**961.294**	**816.081**	**553.984**	**2,331.359**
Hydropower (1960)	407.338	776,898.826	398.760	776,898.826	-	-	-	-
TOTAL	491.42	937,257.83	504.838	983,560.188	**1,419.257**	**1,376.827**	**993.005**	**3,789.089**

NOTE: Rounding down to pool elevation 1,073.95 ft results in 73.450 ac-ft of non-allocated storage.

Lowering the bottom of conservation pool to EL 1,073.96 ft-NGVD (as opposed to 1,073.95 ft-NGVD) would have resulted in reducing the existing hydropower storage allocation by about 73.450 AF.

The new bottom of conservation pool at EL 1,073.95 ft-NGVD would have storage of 983,569.919 AF and a firm yield of 504.876 MGD.

Figure 2 shows the firm yield for additional storage reallocated from the inactive pool that is associated with the Base condition.

2.6 Frequency Data

The daily average river flows, river stages, lake outflows, and pool elevation generated for each RiverWare model simulations were computed by RiverWare into annual series discharge-frequency curves at each lake and control point for the Base condition and for each alternative reallocation plan. Although the RiverWare data output is daily average, the estimated peak flow and stage data for significant events was investigated and found to range from one (1) to five (5) percent higher. However, since relative comparisons are being used to determine plan impacts it was ascertained that use of the daily averages would not change the findings of this study.

2.7 Duration Data

RiverWare provided daily average river flows, river stages, lake outflows, and pool elevations results from the each simulation as elevation-duration, lake outflow-duration, river flow-duration, and river stage-duration at each lake and control point for Base conditions and for alternative reallocations plans based on daily values.

2.8 Climate Trends and Considerations

The Little Rock Hydraulics and Technical Services in coordination the Little Rock United States Geological Survey (USGS) to analyze long term rain trends in the region. The study found a statistically significant probability ($p<0.1$)that total annual rainfalls are increasing in the Beaver Basin by about 0.11 to 0.12 inches per year with the only season showing statistically significant uptick in rainfall being in the spring. This result indicates that Beaver Lake can expect better recovery of conservation/seasonal pool after the dry summer and fall seasons, but not an improvement in yield during dry periods.

3. Hydraulic Analysis

No special hydraulic modeling (HEC-RAS) was done for determining water surface elevations along the downstream reaches of the White River. The standard economic flood risk management impact data associated with downstream control points rating curves were deemed sufficient for evaluating the RiverWare results for the scope of this study. These flood damage impacts are discussed in Section 5.8 of the report. The flows and stages were based on RiverWare routings and the latest rating curves available (SWL Reservoir Control' DSS data base) at the control points.

4. Results

4.1 White River Lakes

The impacts to the lakes from a frequency and duration analysis are very minor. Visual examination shows little differences in the alternatives. However, although slight, the alternatives do have some impact. Section 5.8 Reallocation within the flood pool at Beaver Lake discussed the flood risk management impacts and Sections 5.14 through 5.16 address the hydropower impacts. Appendix E, Hydropower Analysis Center (HAC) Report, contains the RiverWare output results pertinent to the hydropower analysis.

4.1.1 Frequency

The five maximum flood events for Beaver that were computed by RiverWare for each simulation during the 72-year period-of-record for each alternative are shown in Table 6. There are minimal differences in the maximum pool elevations for these five events. The maximum impacts to pool elevation are at the lower frequencies with an increase of about 1.4 ft for a 0.5 ACE event and 0.5 ft for a 0.2 ACE event the reallocation from flood pool alternative. Since the White River is operated as a system, any modifications to any one lake can impact the other five lakes in the system. The impacts to the others lakes five maximum events are insignificant.

The five minimum pool elevations during drought events for Beaver Lake are shown in Table 6. The maximum impacts of the alternatives are all less than 2.75 ft with the reallocation from the conservation pool having the greatest impact. The impacts to the other lakes for these events are less than 1.0 ft. A significant impact associated with the reallocation from flood pool was that the frequency at which the top of flood pool was exceeded changed from approximately a 0.2 Annual Chance of Exceedance (ACE) to a 0.5 ACE – a shift for a 1 in 5 chance to a 1 in 2 chance of occurrence. When the flood pool is exceeded a surcharge operation is induced – a surcharge operation usually results in large releases with downstream economic damages.

Table 6: Five Flood and Drought Events

Beaver Lake Pool Elevations for Five Flood and Five Drought Events For Riverware Model Simulations RW-W15X03 (Base) RW-W15X03- 22mgd_BV (Conservation) RW-W15X03+ 22mgd_BV (Flood) RW-W15X03-22mgd-From-DeadPool (Inactive) for the Period of Simulation WY 1941-2011				
FLOOD EVENTS	Beaver Lake			
	Pool Elevation	Pool Elevation	Pool Elevation	Pool Elevation
	RW-W15X03	RW-W15X03-22mgd_BV	RW-W15X03+ 22mgd_BV	RW-W15X03-22mgd-From-DeadPool
	Base	Conservation	Flood	Inactive
	Max Pool EL	Max Pool EL	Max Pool EL	Max Pool EL
1945	1,131.27	1,131.27	1,131.27	1,131.27
1990	1,131.02	1,131.02	1,131.02	1,131.02
2011	1,130.86	1,130.85	1,130.85	1,130.85
1957	1,130.84	1,130.84	1,130.84	1,130.84
2008	1,130.74	1,130.73	1,130.73	1,130.73
DROUGHT EVENTS	Beaver Lake			
	Pool Elevation	Pool Elevation	Pool Elevation	Pool Elevation
	RW-W15X03	RW-W15X03-22mgd_BV	RW-W15X03+ 22mgd_BV	RW-W15X03-22mgd-From-DeadPool
	Min Pool EL	Min Pool EL	Min Pool EL	Min Pool EL
	Bottom Conservation Pool (BCP) 1,077.00 feet			BCP 1,073.96 feet
2006-2007	1,098.80	1,096.92	1,099.24	1,096.92
1952-1957	1,103.80	1,102.00	1,104.26	1,102.00
1964-1968	1,106.82	1,104.08	1,106.20	1,104.08
1980-1983	1,106.05	1,104.40	1,105.56	1,104.40
1999-2002	1,107.49	1,106.83	1,108.92	1,106.83

The maximum difference in Beaver Lake releases (outflow) increased by 31 percent for the Flood alternative and reduced by less than 1 percent for the Conservation and Inactive alternatives for the 1945 flood event period of simulation. As noted in the previous paragraph, the reallocation from flood pool results in more frequent surcharge releases from 0.2 ACE to 0.5 ACE. Surcharge releases are made through the Tainter gates and therefore are flows lost to hydropower production. Surcharge releases are of large enough scale that they often cause adverse economic impacts.

The existing flood pool is 287,300 AF, which is 4.54 inches of rainfall runoff. The reallocation from flood pool would reduce the flood pool runoff by 0.76 inches to 3.79. Runoff from an event in the basin typically ranges from 60% to 90% of rainfall. Atlas 14 72-hour point rainfall at the Beaver Dam is 5.89 inches, 0.2 ACE and 4.83 inches, 0.5 ACE. The Atlas 14 results conform to the RiverWare analysis, in that it shows that a 0.2 ACE event with 77 percent runoff fills the existing flood pool to cause a surcharge operation and that a 0.5 event with 78 percent runoff fills the proposed flood pool to cause a surcharge operation. See Table 7: Operational Impact to Reallocation from Flood Pool.

Table 7: Operational Impact to Reallocation from Flood Pool

	Units	Current Condition	Approximate Proposed	Difference
Top of Conservation Pool	ft	1,120.43	1,122.1	1.67
Flood Pool Volume	ac-ft	287,300	239,470	47,830
Flood Pool Runoff Volume	inches	4.54	3.79	0.76
Spillway Events During Period of Record		14	34	20
Spillway Event Prob.	ACE	0.2	0.5	0.3
Equivalent release ACE to rainfall (Altas-14 72-hr point)	inches	5.89	4.83	1.06

An additional 0.76 inches of runoff to pass through the gates equals 7,052 CFS spillway release increase averaged over 72 hours.

Graphical plots and tabulated frequency data of the maximum and minimum pool elevations and outflow for Beaver Lake are shown in Section Appendix B-2. The results are available in the Hydrology and Hydraulics Section of the Little Rock District upon request.

4.1.2 Duration

Section 8.Appendix B-3, Beaver Lake Elevation and Outflow Duration, presents the graphical plots and tables for the annual pool elevations and lake outflow duration for Beaver Lake. The comparative duration results in 1.16 ft in the pool and change of 154 CFS at the median outflow. The results are available in the Hydraulics and Technical Service Branch of the Little Rock District upon request.

4.2 White River

The impacts to the downstream control points from a frequency and duration analysis are very minor for all alternatives except for a reallocation from flood pool. Visual examination show little differences in the reallocation from conservation and inactive pool alternatives. Section 5.8 reallocation within the flood pool addresses the flood damage impacts.

4.2.1 Frequency

Table 9 shows the maximum difference in flows and stages at the downstream control point, Table Rock Lake, increased by 0 percent for the Flood alternative and decreases by 0 percent for the Conservation and Inactive alternatives for the 1945 flood event which is the maximum event for the period of simulation.

Graphical plots and tabulated frequency data of the maximum flow and stage for the downstream reservoirs (Table Rock and Bull Shoals) are shown in Section 8.Appendix B-4 Downstream Reservoirs: Table Rock and Bull Shoals Lakes Elevation and Outflow Frequency. The impacts at the other control points and lakes were deemed negligible and thus not presented in this report. The results are available in the Hydraulics and Technical Branch of the Little Rock District upon request.

4.2.2 Duration

Section 8.Appendix B-5 Downstream Reservoirs: Table Rock and Bull Shoals Lakes Elevation and Outflow Duration, presents the graphical plots and tables for annual flow and stage for the downstream lakes Table Rock and Bull Shoals. The impacts at the other control points and lakes were deemed negligible and thus not presented in this report. The results are available in the Hydraulics and Technical Services Branch of the Little Rock District upon request.

5. Conclusion

The reallocation of storage in Beaver Lake for water supply will provide firm yield (dependable yield) of 12 MGD for Benton-Washington Regional Public Water Authority, 6 MGD for Carroll-Boone Water District, and 4 MGD for Madison County Regional Water District. This reallocation will have minimal impact if reallocated from conservation or inactive pool; however, a reallocation from flood pool increases damaging releases and downstream lake elevations during extreme events and is NOT recommended.

6. References

EM 1110-2-1420 Hydrologic Engineering Requirements for Reservoirs, 31 October 1997.

EM 1110-2-1419 Hydrologic Frequency Analysis, 5 March 1993.

ER 1165-2-119 Modifications to Completed Projects, 20 September 1982.

Trends in Precipitation, Streamflow, Reservoir Pool Elevations, and Reservoir Releases in Arkansas and Selected Sites in Louisiana, Missouri, and Oklahoma, 1951-2011

Appendix B-1 White River RiverWare Simulation Computer Model Description

1. General

The U.S. Army Corps of Engineers Little Rock District (USACE-SWL) operates the White River System of Reservoirs in Arkansas and Missouri for the authorized purposes of flood control, hydropower, water supply, and water quality. From the mid-1980's through the late 1990's a reservoir simulation model named SUPER was developed and used to study various operational alternatives for the White River System. In 1999 a Southwestern Division (SWD) wide team was created to evaluate simulation capabilities of the Districts, and it was determined that a new basin simulation model was mission-essential. Papers previously published (Daylor, J., et al. (2006); and Avance, A. et al. (2010)) describe the history of the development of SWD-USACE reservoir operations methods in RiverWare in conjunction with University of Colorado Center for Advanced Decision Support for Water and Environmental Systems (CU-CADSWES). The Arkansas River system had been selected for the prototype RiverWare enhancement, testing, and evaluation case, and a RiverWare model was developed for the portion of the Arkansas River watershed that extends from central and southeast Kansas, through Oklahoma, and into Arkansas ending at Little Rock.

Little Rock District followed suit shortly thereafter in developing a replacement RiverWare White River System model to replace the district's SUPER White River System model. The RiverWare White River model required CU-CADWES to develop some new routines to match the SUPER storage allocation method (described in section 7 of this document). Once the models had full agreement in calculation behavior a few minor operational calculation mistakes discovered in the SUPER logic were rewritten to more closely model the Water Control Plan.

2. Hydrologic Input Data

The RiverWare computer model is a period of record simulation model using a routing interval of one day. The hydrologic input to the model, for every reservoir and stream control point, is the period of record uncontrolled area flow. That is, at any of these controls, the input hydrograph constitutes all flow which is attributable to the drainage above that point but below the first upstream reservoir on the tributaries that contribute to that point. The development of these uncontrolled data hydrographs is based on computations that utilize all available pertinent daily records and multi-reach storage vs. discharge (Puls) stream routing relationships. The hydrologic input data is an estimate of the period of record hydrographs that would result if all reservoirs in the modeled area were of infinite storage capacity and no releases were ever made.

3. Reservoir System and Regulation Plan Description Data

The basic input data required to describe the reservoirs includes area-capacity curves, maximum discharge curves, and minimum (induced surcharge) discharge curves. In addition, the relationship of the reservoirs to one another is defined by a seasonal function of storage vs. operating level for each reservoir. The purpose for these is to provide operational priority to achieve balance among the reservoirs. Two reservoirs are considered in balance when they are at the same operating level as determined from their respective storage-level functions and contents. The relationship of each control point to each reservoir is provided by a set of routing coefficients for each control point below the reservoir. This provides the way for determined releases to be routed downstream from each reservoir to be added to the input uncontrolled area hydrographs to produce the regulated hydrograph at the downstream control points. The regulating discharge criteria are supplied for all stream control points (including reservoir outflow controls) as a seasonal function of a system state parameter. The parameter can be the current level or the forecast level of a particular reservoir, or the percent of flood storage forecast to be used in a specified group of reservoirs.

4. Simulation of Streamflow Forecast

The RiverWare model iterates sequentially through each day of the period of record determining releases that adhere to the plan of flood control regulation, taking into account hydrologic conditions on each particular day. In order to achieve realism in the flood release schedules each day, it is necessary to simulate a forecast of the flows expected as reservoir inflow and at the stream control points. The objective is for the simulated forecast to be reasonably equivalent to a real-time forecast, based on the rainfall and stream flow data that would be available at that time. The forecast is simulated at each model control point by use of an input specified number of days, beginning with the current day, in which flows are known perfectly. Beyond the span of perfect knowledge, future flows are estimated by use of the input normal recession factors for each individual control point.

5. Mandatory Flood Release Schedule

The mandatory flood release schedule is the first major determination made each day of the period of record. These releases are forced releases made only from the flood pool and surcharge pool because the flood pool would be exceeded during the forecast period. The procedure is to determine a release schedule that begins immediately and will minimize the maximum outflow rate and will stay within the restraints provided by the minimum discharge curve and the maximum discharge curve. This schedule is computed for the forecast period beginning with upstream reservoirs. The mandatory release schedule for a reservoir, once determined, is routed downstream from that reservoir and added to the inflow forecast of the first reservoir downstream of it. In this manner, mandatory flood releases from upstream reservoirs are taken into account when the downstream reservoir's mandatory release schedule is computed. In addition, mandatory releases are routed and added to the forecast hydrographs at all control points between the reservoir and it's nearest downstream reservoir.

6. Regulation Targets and Available Channel Space Determination

Subsequent to the development and routing of the mandatory release schedule, the flood regulation target flow is determined for each day of the forecast period based on the input regulating discharge function, the current date, and the appropriate parameter for each control point. Once this is accomplished, the space available, by day through the forecast period for flood releases, is determined for each control point by subtracting the forecast flow from the regulating discharge target.

7. Forecast Reservoir Levels and Target Balance Levels

The next major step performed by the model is to determine the maximum level each reservoir would reach during the forecast and scheduling period if no flood releases in addition to the mandatory releases were made. Once this is done, all reservoirs are arranged in order by maximum forecast level. Several stream flow control points were designated in the input as “key” control points and the reservoirs that are subject to each of these “key” control points were identified. A target balance level is then determined for each "key" control point where the forecast storage in the identified reservoirs that are above the target balance level equals the release volume that can be moved through the available channel space at the "key" control point over the forecast and release scheduling period. The target balance levels for all of the "key" control points are then arranged in order by level to form the basis for a series of iterations through the entire system of reservoirs. During each of these iterations, all of the reservoirs which are forecast to be above that level are considered in the development of the flood control release schedules.

8. Flood Control Release Schedule Development

A series of iterations are performed in which the flood control release schedules for the system of reservoirs are incrementally increased. There is one iteration for each of the target balance levels determined for the "key" control points considered in descending order of magnitude by level. On a particular iteration, only those reservoirs that were forecast to be higher than the corresponding target balance level are considered, and on any iteration the maximum volume of flood water that is subject to scheduling is limited to the volume of water above the highest target balance level which is associated with any "key" control point to which it is subject. For each reservoir, in turn, during a particular iteration, all of the control points and reservoirs below that reservoir are evaluated to develop a schedule which releases the flood water at the earliest possible time but is subject to the constraints listed below.

a) The first flood release (current day) cannot exceed the previous day release plus the allowable rising release change rate.

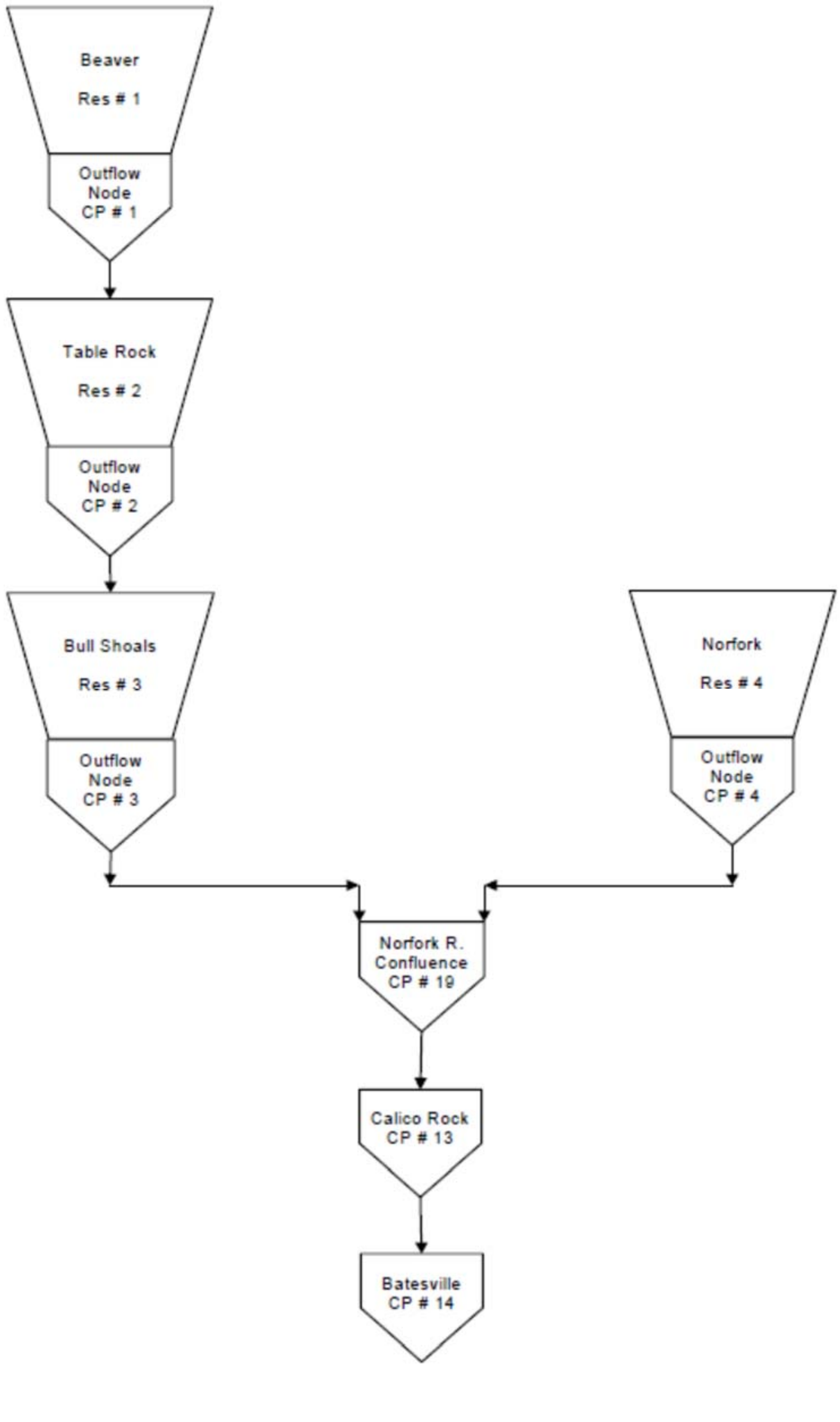
b) The adjacent day's release schedule cannot vary by more than a prescribed amount.

c) As the flood pool nears empty, the release schedule must decrease each day at a rate no greater than the maximum allowable falling release change rate.

d) The routed releases must not exceed the available space at key and non-"key" control points giving consideration to space that already has been reserved for another reservoir's release schedule. For "key" control points, only a share of the space can be considered for use by the current reservoir based on its reservation established during development of the target balance level associated with that control point.

e) Space is available for storage in downstream tandem reservoirs above each reservoir's forecast maximum level but below the target balance level unless it has already been reserved for another reservoir's release schedule. The available storage space in the downstream reservoir is used to reduce the release schedule that is evaluated at control points below the downstream reservoir.

On the last iteration the target level is set to the top of conservation pool and all reservoirs are allowed to release to fill in available space at the control points. As the procedure sets reservoir releases it checks the above constraints, until a final schedule is achieved that is within all constraints.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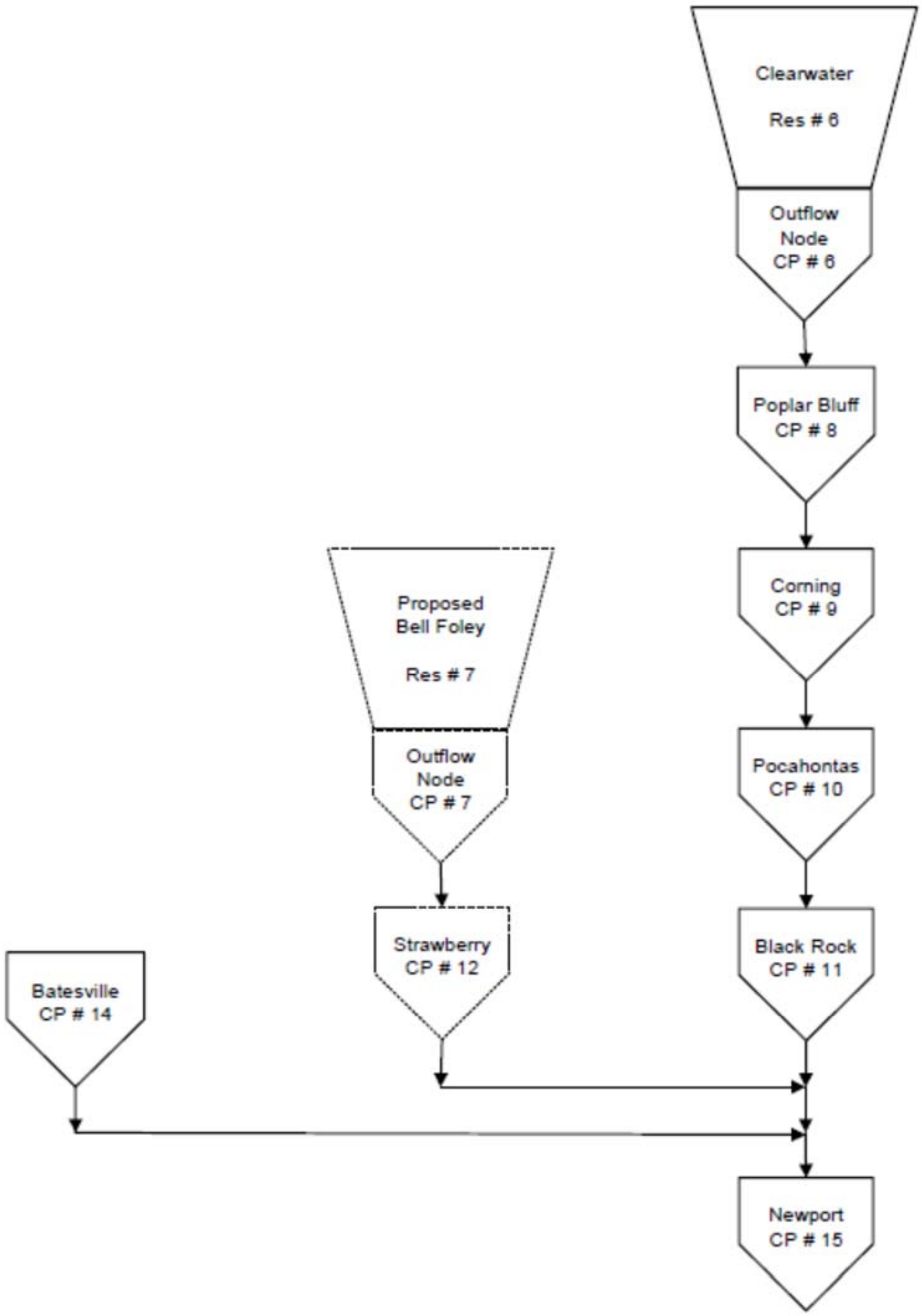
Res # 1
Outflow
Node
CP # 1
Table Rock
Res # 2
Outflow
Node
CP # 2
Bull Shoals
Res # 3
Outflow
Node
CP # 3
Norfork
Res # 4
Outflow
Node
CP # 4
Norfork R.
Confluence
CP # 19
Calico Rock
CP # 13
Batesville
CP # 14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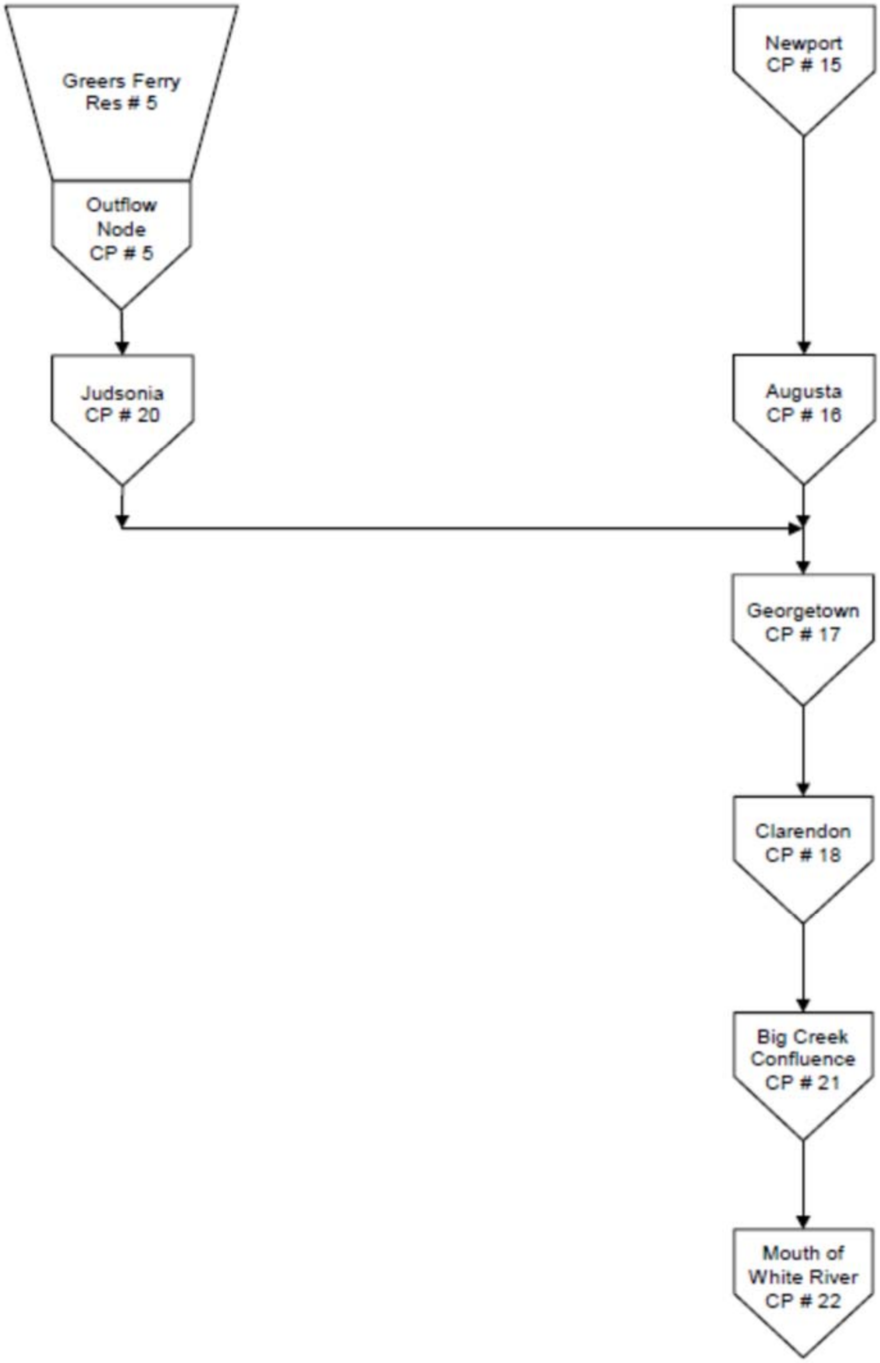
Res # 6
Outflow Node CP # 6
Poplar Bluff CP # 8
Proposed Bell Foley
Res # 7
Corning CP # 9
Outflow Node CP # 7
Pocahontas CP # 10
Strawberry CP # 12
Black Rock CP # 11
Batesville CP # 14
Newport CP # 15


Greers Ferry
Res # 5
Outflow
Node
CP # 5
Judsonia
CP # 20
Newport
CP # 15
Augusta
CP # 16
Georgetown
CP # 17
Clarendon
CP # 18
Big Creek
Confluence
CP # 21
Mouth of
White River
CP # 22

Appendix B-2 Beaver Lake Elevation and Outflow Frequency

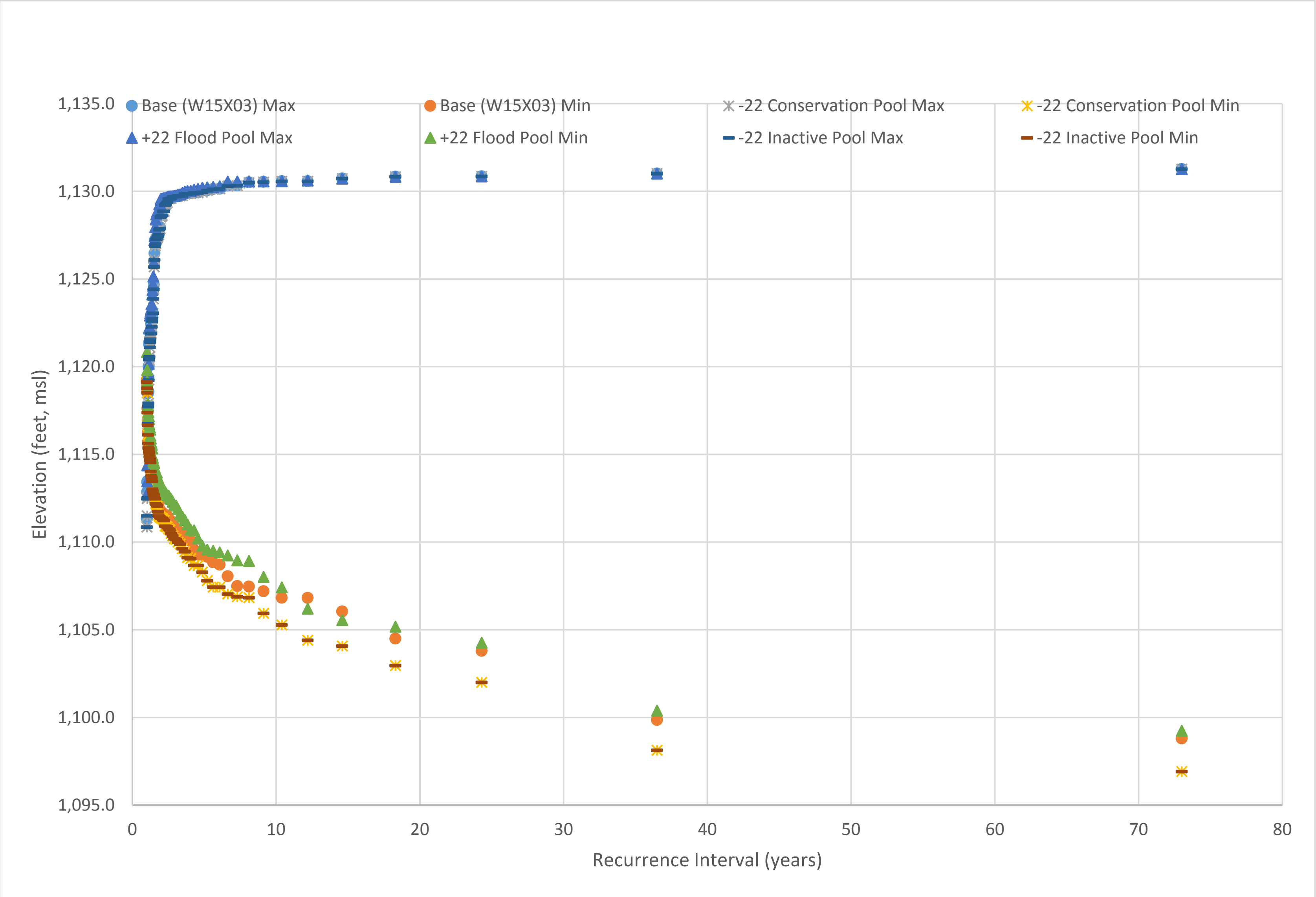


Figure 1: Beaver Lake - Elevation Frequency Curve

Table 8: Beaver Max/Min RiverWare Pool elevation Frequency

	Base (W15X03)				-22 Conservation Pool				+22 Flood Pool				-22 Inactive Pool				Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min		
1	1945	1,131.3	2007	1098.8	1945	1131.3	2007	1096.9	1945	1131.3	2007	1099.2	1945	1,131.3	2007	1096.9	0.014	73.0
2	1990	1,131.0	2006	1099.9	1990	1131.0	2006	1098.1	1990	1131.0	2006	1100.4	1990	1,131.0	2006	1098.1	0.027	36.5
3	2011	1,130.9	1955	1103.8	2011	1130.9	1955	1102.0	2011	1130.9	1955	1104.3	2011	1,130.9	1955	1102.0	0.041	24.3
4	1957	1,130.8	1954	1104.5	1957	1130.8	1954	1103.0	1957	1130.8	1954	1105.2	1957	1,130.8	1954	1103.0	0.055	18.3
5	2008	1,130.7	1981	1106.0	2008	1130.7	1965	1104.1	2008	1130.7	1981	1105.6	2008	1,130.7	1965	1104.1	0.068	14.6
6	1973	1,130.6	1965	1106.8	1973	1130.6	1981	1104.4	1974	1130.6	1965	1106.2	1973	1,130.6	1981	1104.4	0.082	12.2
7	1985	1,130.6	1967	1106.8	1985	1130.6	1964	1105.3	1950	1130.6	1964	1107.4	1985	1,130.6	1964	1105.3	0.096	10.4
8	1974	1,130.5	1964	1107.2	1974	1130.5	1967	1105.9	1973	1130.6	1967	1108.0	1974	1,130.5	1967	1105.9	0.110	9.13
9	1950	1,130.5	2011	1107.5	1950	1130.5	2000	1106.8	1985	1130.6	2000	1108.9	1950	1,130.5	2000	1106.8	0.123	8.11
10	1943	1,130.3	2000	1107.5	1943	1130.3	2011	1106.9	1961	1130.6	2011	1109.0	1943	1,130.3	2011	1106.9	0.137	7.30
11	1961	1,130.3	1956	1108.1	1961	1130.3	1957	1107.0	1943	1130.6	1957	1109.2	1961	1,130.3	1957	1107.0	0.151	6.64
12	1993	1,130.1	1957	1108.7	1993	1130.1	1956	1107.4	1960	1130.3	1982	1109.4	1993	1,130.1	1956	1107.4	0.164	6.08
13	1960	1,130.1	2001	1108.8	1960	1130.1	2001	1107.4	1949	1130.2	1956	1109.5	1960	1,130.1	2001	1107.4	0.178	5.62
14	1995	1,130.1	1968	1109.2	1995	1130.0	1968	1107.8	1988	1130.2	2001	1109.6	1995	1,130.0	1968	1107.8	0.192	5.21
15	1949	1,130.0	1979	1109.3	1949	1129.9	1982	1108.3	2002	1130.2	1968	1109.8	1949	1,129.9	1982	1108.3	0.205	4.87
16	1975	1,129.9	1977	1109.3	1975	1129.9	1977	1108.7	1993	1130.1	1980	1110.2	1975	1,129.9	1977	1108.7	0.219	4.56
17	1958	1,129.9	2002	1109.6	1958	1129.9	1979	1108.7	1995	1130.1	1977	1110.7	1958	1,129.9	1979	1108.7	0.233	4.29
18	1988	1,129.9	2004	1110.1	1988	1129.9	2002	1109.1	1946	1130.0	1979	1110.7	1988	1,129.9	2002	1109.1	0.247	4.06
19	2009	1,129.9	1983	1110.3	2009	1129.9	1980	1109.1	2009	1130.0	2002	1111.0	2009	1,129.9	1980	1109.1	0.260	3.84
20	2002	1,129.9	1980	1110.3	2002	1129.8	1966	1109.5	1975	1130.0	1996	1111.3	2002	1,129.8	1966	1109.5	0.274	3.65
21	1998	1,129.8	1996	1110.5	1998	1129.8	2004	1109.6	1958	1129.9	1966	1111.5	1998	1,129.8	2004	1109.6	0.288	3.48
22	1994	1,129.8	1982	1110.6	1994	1129.7	1983	1109.9	1997	1129.8	2004	1111.6	1994	1,129.7	1983	1109.9	0.301	3.32
23	1997	1,129.7	1972	1110.7	1997	1129.7	1996	1110.0	1998	1129.8	1983	1111.9	1997	1,129.7	1996	1110.0	0.315	3.17
24	1969	1,129.7	2003	1110.8	1968	1129.7	1972	1110.2	1994	1129.8	1972	1112.1	1968	1,129.7	1972	1110.2	0.329	3.04
25	1968	1,129.7	1973	1110.8	1969	1129.7	2008	1110.2	1969	1129.7	2008	1112.1	1969	1,129.7	2008	1110.2	0.342	2.92
26	1946	1,129.7	1966	1110.9	1946	1129.7	1973	1110.4	1986	1129.7	1973	1112.3	1946	1,129.7	1973	1110.4	0.356	2.81
27	1979	1,129.7	1948	1111.2	1951	1129.6	2003	1110.5	1979	1129.7	2003	1112.4	1951	1,129.6	2003	1110.5	0.370	2.70
28	1986	1,129.6	1989	1111.2	1986	1129.6	1948	1110.7	1947	1129.7	1995	1112.5	1986	1,129.6	1948	1110.7	0.384	2.61
29	1951	1,129.6	2005	1111.4	1979	1129.6	1989	1110.8	1968	1129.7	1989	1112.6	1979	1,129.6	1989	1110.8	0.397	2.52
30	1999	1,129.6	1999	1111.5	1999	1129.4	1953	1110.9	1951	1129.7	1948	1112.7	1999	1,129.4	1953	1110.9	0.411	2.43
31	1947	1,129.4	1990	1111.5	1947	1129.3	2005	1110.9	1989	1129.6	2005	1112.8	1947	1,129.3	2005	1110.9	0.425	2.35
32	1978	1,129.3	1953	1111.5	1952	1129.2	1990	1110.9	1999	1129.6	1953	1112.9	1952	1,129.2	1990	1110.9	0.438	2.28
33	1952	1,129.3	1995	1111.6	2004	1128.9	1999	1111.2	2004	1129.6	1990	1112.9	2004	1,128.9	1999	1111.2	0.452	2.21
34	2004	1,129.3	1985	1111.6	1989	1128.9	1995	1111.3	1952	1129.6	1999	1113.0	1989	1,128.9	1995	1111.3	0.466	2.15
35	1989	1,129.1	1978	1111.7	1987	1128.6	1985	1111.4	1987	1129.6	1998	1113.1	1987	1,128.6	1985	1111.4	0.479	2.09
36	1984	1,129.1	1984	1111.7	1978	1128.6	1998	1111.4	1978	1129.6	1992	1113.2	1978	1,128.6	1998	1111.4	0.493	2.03
37	1987	1,128.7	1998	1111.7	1984	1128.5	1978	1111.4	1984	1129.6	1985	1113.2	1984	1,128.5	1978	1111.4	0.507	1.97

	Base (W15X03)				-22 Conservation Pool				+22 Flood Pool				-22 Inactive Pool				Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min		
38	1942	1,128.0	2008	1111.8	1991	1127.9	1992	1111.4	1991	1129.3	1978	1113.3	1991	1,127.9	1992	1111.4	0.521	1.92
39	1991	1,127.9	1992	1111.9	1942	1127.8	1984	1111.5	1942	1129.3	1984	1113.3	1942	1,127.8	1984	1111.5	0.534	1.87
40	1944	1,127.8	1988	1112.2	1944	1127.5	1963	1111.5	1983	1129.0	1963	1113.5	1944	1,127.5	1963	1111.5	0.548	1.83
41	1983	1,127.6	1976	1112.4	1983	1127.4	1988	1111.7	1970	1128.9	1988	1113.7	1983	1,127.4	1988	1111.7	0.562	1.78
42	1970	1,127.4	1971	1112.5	1970	1127.4	1945	1112.1	1941	1128.8	1994	1113.8	1970	1,127.4	1945	1112.1	0.575	1.74
43	1966	1,127.4	1991	1112.6	1966	1127.3	1976	1112.1	1966	1128.8	1991	1114.0	1966	1,127.3	1976	1112.1	0.589	1.70
44	1941	1,127.3	1945	1112.7	1941	1127.3	1971	1112.1	1944	1128.7	1945	1114.0	1941	1,127.3	1971	1112.1	0.603	1.66
45	2005	1,127.3	1994	1112.7	2005	1127.0	1991	1112.2	2005	1128.4	1976	1114.0	2005	1,127.0	1991	1112.2	0.616	1.62
46	2010	1,127.2	1963	1112.9	2010	1126.9	1970	1112.5	2010	1128.0	1971	1114.0	2010	1,126.9	1970	1112.5	0.630	1.59
47	1953	1,126.5	1970	1112.9	1953	1126.1	1994	1112.5	1953	1127.4	1970	1114.3	1953	1,126.1	1994	1112.5	0.644	1.55
48	1971	1,126.0	1947	1113.0	1971	1125.7	1997	1112.7	1971	1127.2	1997	1114.5	1971	1,125.7	1997	1112.7	0.658	1.52
49	1992	1,124.7	1997	1113.0	1992	1124.4	1947	1112.7	1992	1125.9	1969	1114.5	1992	1,124.4	1947	1112.7	0.671	1.49
50	1976	1,124.3	1969	1113.1	1976	1123.9	1969	1112.7	1976	1125.2	1947	1114.6	1976	1,123.9	1969	1112.7	0.685	1.46
51	1982	1,123.1	1987	1113.2	1982	1123.1	1987	1112.9	1982	1124.7	1987	1114.8	1982	1,123.1	1987	1112.9	0.699	1.43
52	1962	1,122.8	1952	1113.4	1962	1122.7	1952	1113.0	1962	1124.4	1952	1114.9	1962	1,122.7	1952	1113.0	0.712	1.40
53	1948	1,122.6	1986	1113.8	1948	1122.6	1986	1113.5	1948	1124.1	1986	1115.3	1948	1,122.6	1986	1113.5	0.726	1.38
54	1940	1,122.6	1944	1113.9	1940	1122.3	1944	1113.7	1972	1123.6	1944	1115.5	1940	1,122.3	1944	1113.7	0.740	1.35
55	1972	1,122.5	1959	1114.0	1959	1121.9	1960	1113.8	1959	1123.6	1960	1115.7	1959	1,121.9	1960	1113.8	0.753	1.33
56	2001	1,122.5	1960	1114.0	1972	1121.9	1959	1113.8	1940	1123.3	1959	1115.7	1972	1,121.9	1959	1113.8	0.767	1.30
57	1996	1,122.1	1949	1114.4	1996	1121.9	1949	1114.0	1955	1123.2	1949	1115.9	1996	1,121.9	1949	1114.0	0.781	1.28
58	1959	1,121.9	1943	1114.8	1955	1121.6	1943	1114.5	1996	1123.1	1946	1116.1	1955	1,121.6	1943	1114.5	0.795	1.26
59	1955	1,121.6	1946	1115.0	2003	1121.4	1961	1114.7	2003	1123.0	1943	1116.4	2003	1,121.4	1961	1114.7	0.808	1.24
60	1965	1,121.5	1961	1115.0	2001	1121.1	1946	1114.8	2001	1122.9	1975	1116.5	2001	1,121.1	1946	1114.8	0.822	1.22
61	2003	1,121.4	1942	1115.1	1965	1120.6	1942	1114.9	1965	1122.3	1961	1116.5	1965	1,120.6	1942	1114.9	0.836	1.20
62	2007	1,121.4	1975	1115.3	2007	1120.6	1975	1115.1	2007	1122.3	1942	1116.7	2007	1,120.6	1975	1115.1	0.849	1.18
63	2000	1,121.3	1941	1115.4	2000	1120.4	1941	1115.2	2000	1122.2	1941	1117.0	2000	1,120.4	1941	1115.2	0.863	1.16
64	1980	1,120.0	1962	1115.7	1980	1119.2	1950	1115.3	1980	1120.2	1950	1117.2	1980	1,119.2	1950	1115.3	0.877	1.14
65	1956	1,118.6	1950	1115.7	1963	1117.9	1962	1115.4	1963	1119.7	1962	1117.2	1963	1,117.9	1962	1115.4	0.890	1.12
66	1981	1,118.5	2010	1115.7	1977	1117.8	2010	1115.6	1956	1119.6	2010	1117.4	1977	1,117.8	2010	1115.6	0.904	1.11
67	1977	1,118.5	1951	1116.3	1956	1117.7	1951	1116.1	1977	1119.5	1951	1117.8	1956	1,117.7	1951	1116.1	0.918	1.09
68	1963	1,118.5	2009	1117.0	1981	1116.8	2009	1116.7	1981	1117.7	2009	1117.9	1981	1,116.8	2009	1116.7	0.932	1.07
69	1967	1,113.5	1993	1117.6	1967	1112.5	1993	1117.4	1967	1114.4	1940	1118.8	1967	1,112.5	1993	1117.4	0.945	1.06
70	1964	1,113.4	1974	1118.6	1954	1112.5	1974	1118.5	1954	1114.4	1993	1119.2	1954	1,112.5	1974	1118.5	0.959	1.04
71	1954	1,112.9	1940	1118.9	1964	1111.5	1940	1118.8	1964	1113.5	1974	1119.8	1964	1,111.5	1940	1118.8	0.973	1.03
72	2006	1,111.3	1958	1119.3	2006	1110.9	1958	1119.1	2006	1112.7	1958	1120.8	2006	1,110.9	1958	1119.1	0.986	1.01

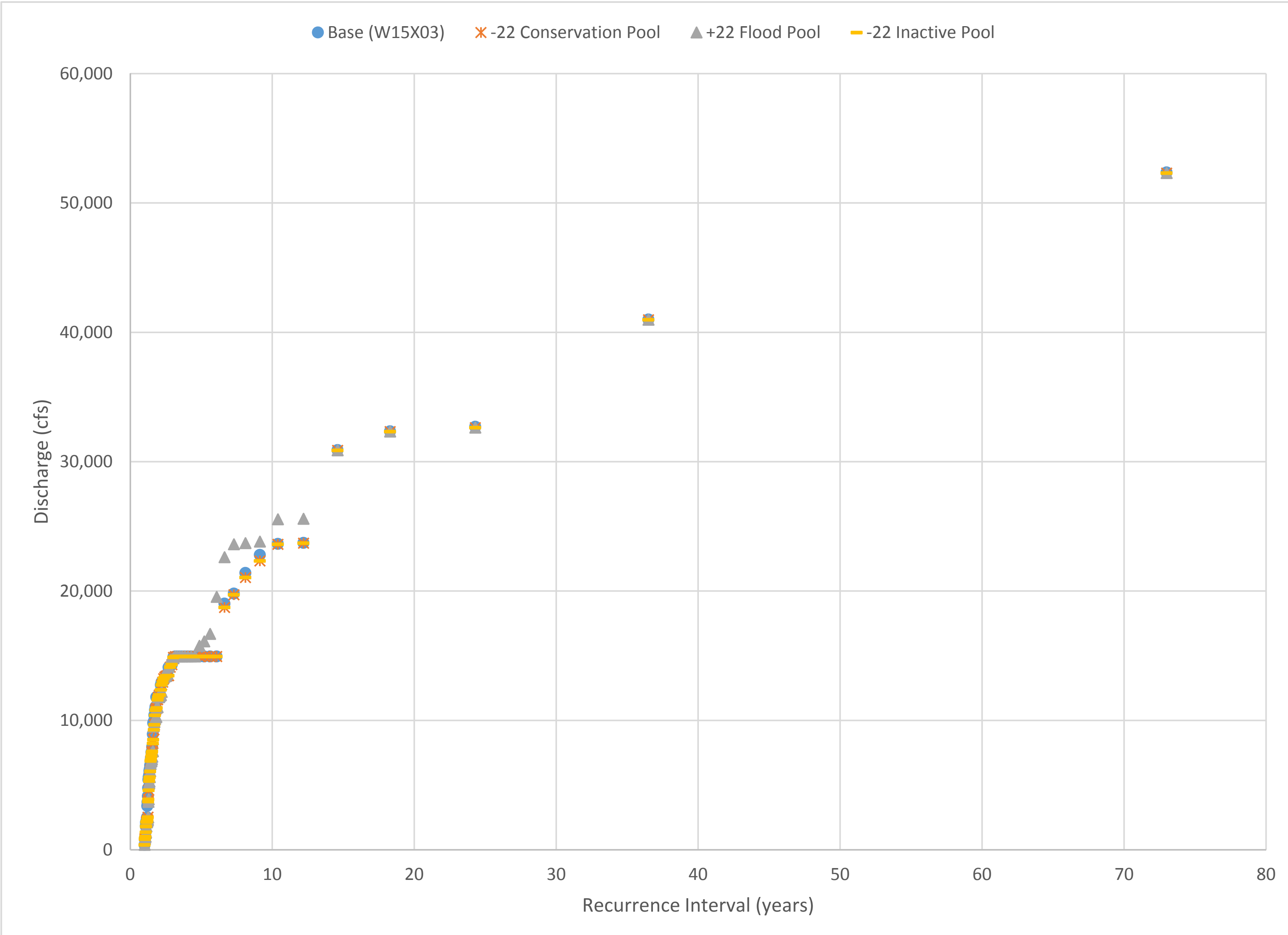


Figure 2: Beaver Lake Outflow Frequency Curve

Table 9: Beaver Lake Outflow Frequency

	Base (W15X03)		-22 Conservation Pool		+22 Flood Pool		-22 Inactive Pool		Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Max	Water Year	Max	Water Year	Max		
1	1945	52357	1945	52310	1945	52310	1945	52310	0.014	73.0
2	1990	40990	1990	40968	1990	40968	1990	40968	0.027	36.5
3	2011	32701	2011	32630	2011	32630	2011	32630	0.041	24.3
4	2008	32343	2008	32329	2008	32329	2008	32329	0.055	18.3
5	1957	30900	1957	30881	1957	30881	1957	30881	0.068	14.6
6	1985	23725	1985	23706	1974	25585	1985	23706	0.082	12.2
7	1973	23644	1973	23613	1943	25546	1973	23613	0.096	10.4
8	1974	22792	1974	22329	1961	23822	1974	22329	0.110	9.13
9	1950	21402	1950	21051	1985	23706	1950	21051	0.123	8.11
10	1943	19804	1943	19718	1973	23613	1943	19718	0.137	7.30
11	1961	19034	1961	18732	1950	22612	1961	18732	0.151	6.64
12	1951	14945	1951	14945	2002	19548	1951	14945	0.164	6.08
13	1952	14945	1952	14945	1988	16686	1952	14945	0.178	5.62
14	1986	14945	1986	14945	1960	16113	1986	14945	0.192	5.21
15	1988	14945	1988	14945	1949	15765	1988	14945	0.205	4.87
16	1997	14945	1997	14945	1998	14945	1997	14945	0.219	4.56
17	1998	14945	1998	14945	1951	14945	1998	14945	0.233	4.29
18	1987	14945	1987	14945	1987	14945	1987	14945	0.247	4.06
19	1944	14945	1944	14945	1997	14945	1944	14945	0.260	3.84
20	1949	14945	1949	14945	1944	14945	1949	14945	0.274	3.65
21	1962	14945	1962	14945	1962	14945	1962	14945	0.288	3.48
22	1989	14945	1989	14945	1989	14945	1989	14945	0.301	3.32
23	2010	14945	2010	14945	2010	14945	2010	14945	0.315	3.17
24	1978	14894	1978	14872	1986	14804	1978	14872	0.329	3.04
25	1968	14301	1968	14317	1968	14699	1968	14317	0.342	2.92
26	1953	14209	1953	14123	1978	14671	1953	14123	0.356	2.81
27	1960	14099	2002	13462	1953	14154	2002	13462	0.370	2.70
28	2002	13611	1960	13455	1941	13597	1960	13455	0.384	2.61
29	1993	13464	1993	13435	1993	13435	1993	13435	0.397	2.52
30	1941	13187	1941	13355	1948	13409	1941	13355	0.411	2.43
31	1958	13114	1958	13231	1952	13407	1958	13231	0.425	2.35
32	1947	13029	1999	12962	1995	13175	1999	12962	0.438	2.28
33	1999	12962	1969	12749	1946	12196	1969	12749	0.452	2.21
34	1969	12737	1948	12362	1971	11953	1948	12362	0.466	2.15

	Base (W15X03)		-22 Conservation Pool		+22 Flood Pool		-22 Inactive Pool		Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Max	Water Year	Max	Water Year	Max		
35	1984	12046	1971	11966	1999	11896	1971	11966	0.479	2.09
36	1971	11964	1946	11960	1942	11802	1946	11960	0.493	2.03
37	1946	11904	1942	11802	2009	11785	1942	11802	0.507	1.97
38	1948	11872	1995	11604	1982	11025	1995	11604	0.521	1.92
39	1995	11820	1970	10962	1958	10985	1970	10962	0.534	1.87
40	1942	11802	1947	10917	1976	10272	1947	10917	0.548	1.83
41	1970	11055	1982	10798	1970	10223	1982	10798	0.562	1.78
42	1982	10798	1976	10395	1975	10104	1976	10395	0.575	1.74
43	1976	10402	1984	9660	1984	9875	1984	9660	0.589	1.70
44	2004	9923	1975	9279	1947	9580	1975	9279	0.603	1.66
45	1975	9803	2009	8513	1969	9522	2009	8513	0.616	1.62
46	2009	8941	2004	8219	1992	7615	2004	8219	0.630	1.59
47	1983	7960	1992	7610	2004	7190	1992	7610	0.644	1.55
48	1992	7603	1994	7530	1959	7005	1994	7530	0.658	1.52
49	1994	7530	1983	7237	1966	6868	1983	7237	0.671	1.49
50	1959	7083	1959	6980	1983	6812	1959	6980	0.685	1.46
51	1966	6868	1966	6868	1994	6636	1966	6868	0.699	1.43
52	1972	6524	1955	6068	1955	6070	1955	6068	0.712	1.40
53	1940	6237	1979	5619	1979	5619	1979	5619	0.726	1.38
54	1955	6102	1991	5576	1991	5267	1991	5576	0.740	1.35
55	1991	5786	2005	5324	2005	5127	2005	5324	0.753	1.33
56	1979	5619	1940	4602	2001	3895	1940	4602	0.767	1.30
57	2005	5422	2001	3895	1981	3706	2001	3895	0.781	1.28
58	2001	4772	1981	3729	2000	2500	1981	3729	0.795	1.26
59	2003	4144	2000	2529	1996	2311	2000	2529	0.808	1.24
60	1981	3685	1996	2328	1972	2296	1996	2328	0.822	1.22
61	1996	3386	2003	2212	2003	2190	2003	2212	0.836	1.20
62	2000	2512	1972	2189	1980	2168	1972	2189	0.849	1.18
63	2007	2324	1980	2181	2006	2121	1980	2181	0.863	1.16
64	1980	2168	2006	2149	1956	1814	2006	2149	0.877	1.14
65	2006	2129	1956	1836	1965	1787	1956	1836	0.890	1.12
66	1965	2111	1965	1807	2007	1348	1965	1807	0.904	1.11
67	1956	1823	2007	1361	1940	1284	2007	1361	0.918	1.09
68	1963	1014	1963	1018	1963	1008	1963	1018	0.932	1.07
69	1954	1004	1954	1013	1954	1000	1954	1013	0.945	1.06

	Base (W15X03)		-22 Conservation Pool		+22 Flood Pool		-22 Inactive Pool		Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Max	Water Year	Max	Water Year	Max		
70	1977	910	1977	915	1977	906	1977	915	0.959	1.04
71	1964	812	1964	821	1964	811	1964	821	0.973	1.03
72	1967	385	1967	386	1967	382	1967	386	0.986	1.01

Appendix B-3 Beaver Lake Elevation and Outflow Duration

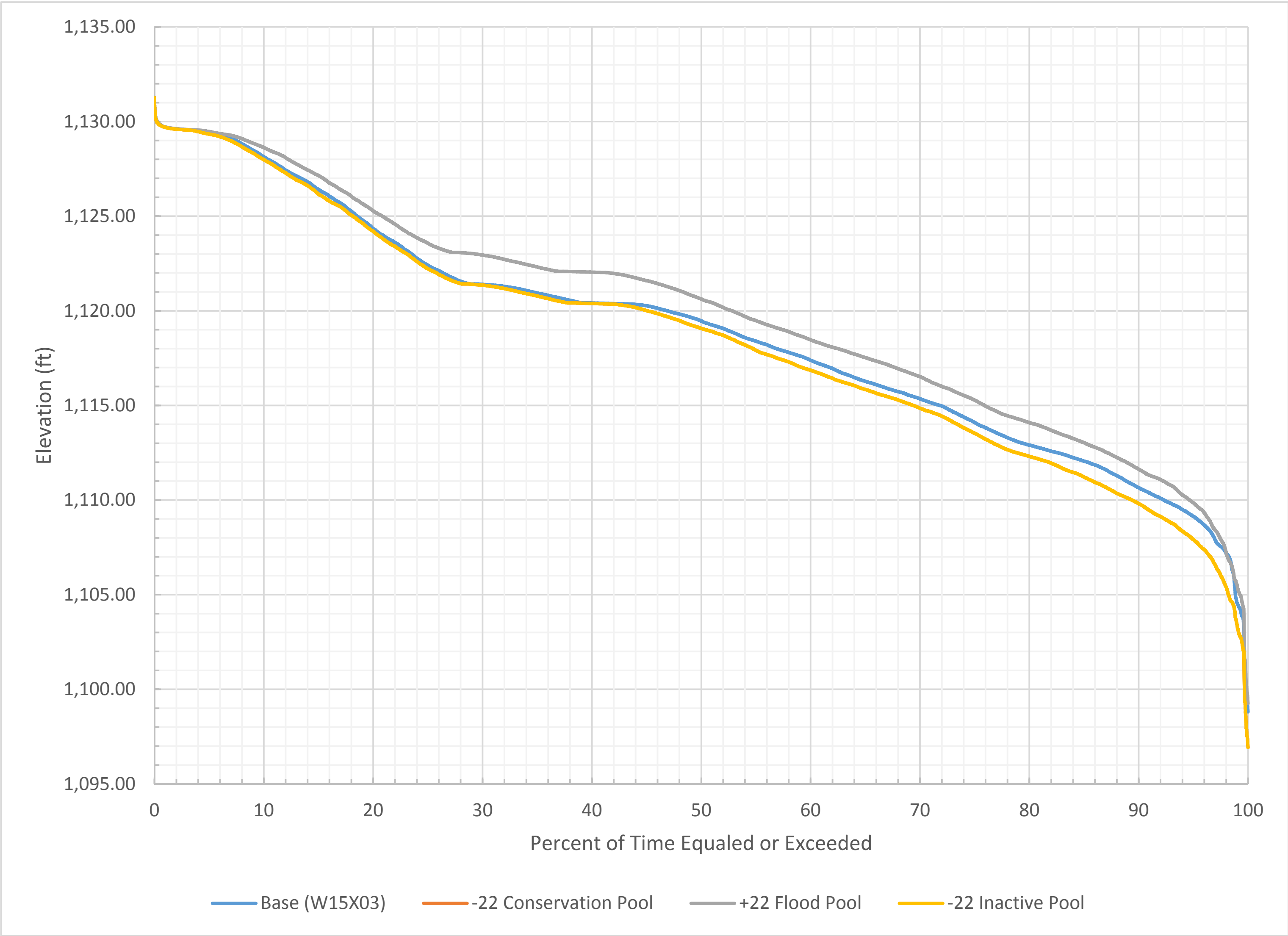


Figure 3: Beaver Lake Pool Elevation Duration Curve

Table 10: Beaver Lake Elevation Duration

Annual Pool Elevation - Duration					Differences in Annual Pool Elevation (Alternative minus Base)		
Percent Equaled or Exceeded	Base (W15X03)	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool
1	1129.70	1129.69	1129.71	1129.69	-0.01	0.01	-0.01
2	1129.60	1129.59	1129.62	1129.59	-0.01	0.01	-0.01
5	1129.38	1129.33	1129.47	1129.33	-0.04	0.09	-0.04
10	1128.14	1127.99	1128.62	1127.99	-0.15	0.49	-0.15
15	1126.41	1126.16	1127.14	1126.16	-0.24	0.74	-0.24
20	1124.35	1124.20	1125.29	1124.20	-0.15	0.94	-0.15
25	1122.40	1122.22	1123.57	1122.22	-0.18	1.17	-0.18
30	1121.39	1121.35	1122.94	1121.35	-0.04	1.55	-0.04
35	1120.94	1120.78	1122.32	1120.78	-0.16	1.38	-0.16
40	1120.41	1120.38	1122.04	1120.38	-0.03	1.62	-0.03
45	1120.26	1120.01	1121.59	1120.01	-0.26	1.32	-0.26
50	1119.46	1119.07	1120.62	1119.07	-0.39	1.16	-0.39
55	1118.39	1117.91	1119.48	1117.91	-0.48	1.09	-0.48
60	1117.38	1116.86	1118.46	1116.86	-0.53	1.08	-0.53
65	1116.27	1115.84	1117.52	1115.84	-0.43	1.25	-0.43
70	1115.35	1114.85	1116.52	1114.85	-0.50	1.17	-0.50
75	1114.10	1113.53	1115.27	1113.53	-0.57	1.18	-0.57
80	1112.90	1112.30	1114.09	1112.30	-0.60	1.19	-0.60
85	1112.05	1111.21	1113.03	1111.21	-0.84	0.98	-0.84
90	1110.65	1109.81	1111.62	1109.81	-0.85	0.97	-0.85
95	1109.13	1107.91	1109.85	1107.91	-1.22	0.72	-1.22
100	1098.80	1096.92	1099.24	1096.92	-1.88	0.44	-1.88

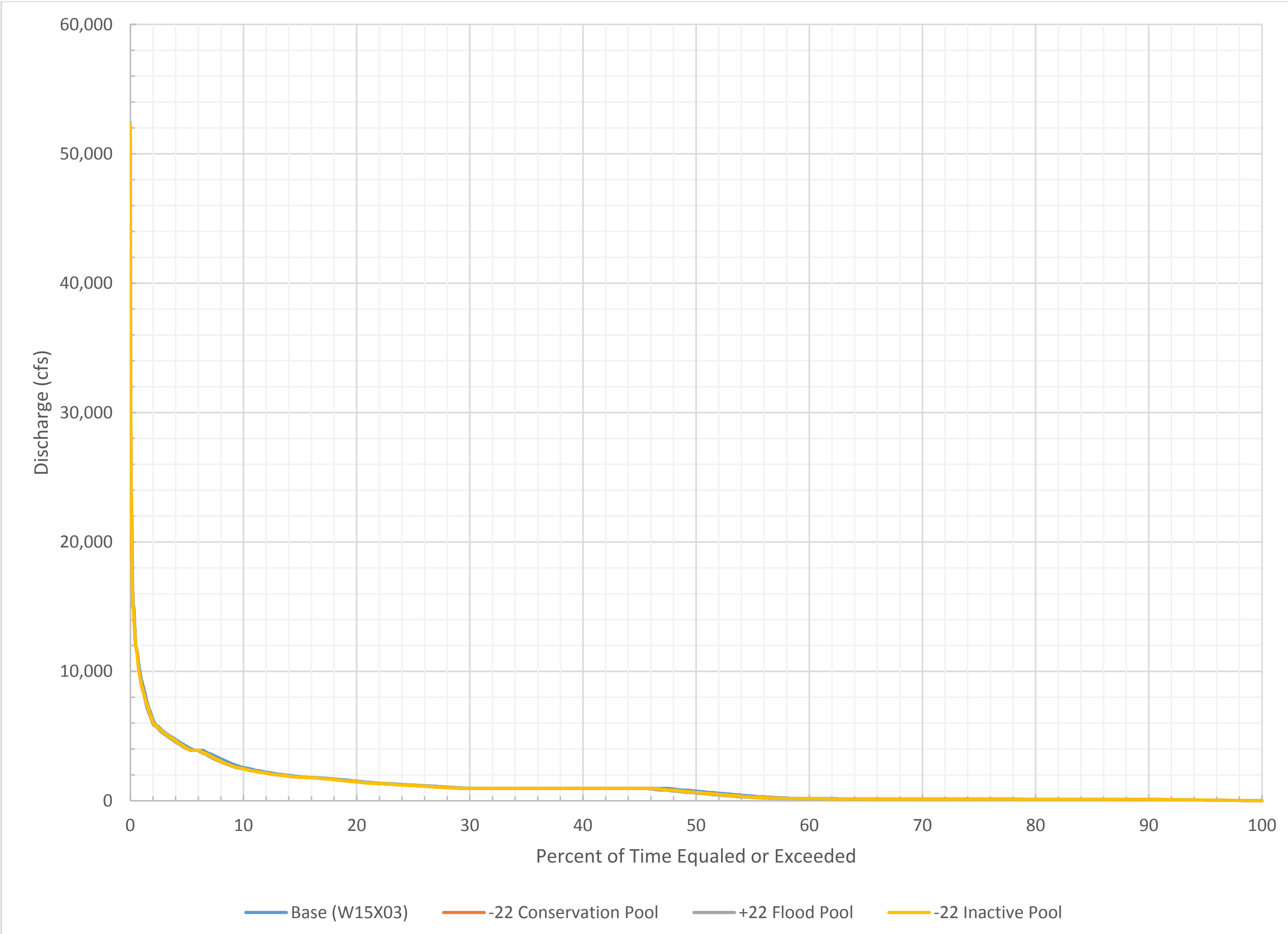


Figure 4: Beaver Lake Outflow Duration Curve

Table 11: Beaver Lake Outflow Duration:

Annual Outflow - Duration					Differences in Annual Outflow (Alternative minus Base)		
Percent Equaled or Exceeded	Base (W15X03)	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool
1	9271	8899	8881	8899	-371	-390	-371
2	6260	6140	5963	6140	-120	-297	-120
5	4162	4039	4016	4039	-123	-146	-123
10	2560	2475	2460	2475	-85	-101	-85
15	1846	1817	1815	1817	-29	-32	-29
20	1507	1442	1488	1442	-65	-19	-65
25	1205	1166	1195	1166	-39	-10	-39
30	959	950	950	950	-9	-9	-9
35	950	950	950	950	0	0	0
40	950	950	950	950	0	0	0
45	950	950	950	950	0	0	0
50	737	639	583	639	-98	-154	-98
55	345	279	252	279	-67	-93	-67
60	169	166	165	166	-3	-4	-3
65	132	131	129	131	-2	-4	-2
70	126	126	125	126	0	-1	0
75	124	124	122	124	0	-1	0
80	120	119	118	119	-1	-2	-1
85	113	112	111	112	-1	-2	-1
90	92	91	90	91	-1	-2	-1
95	51	49	49	49	-2	-2	-2
100	0	0	0	0	0	0	0

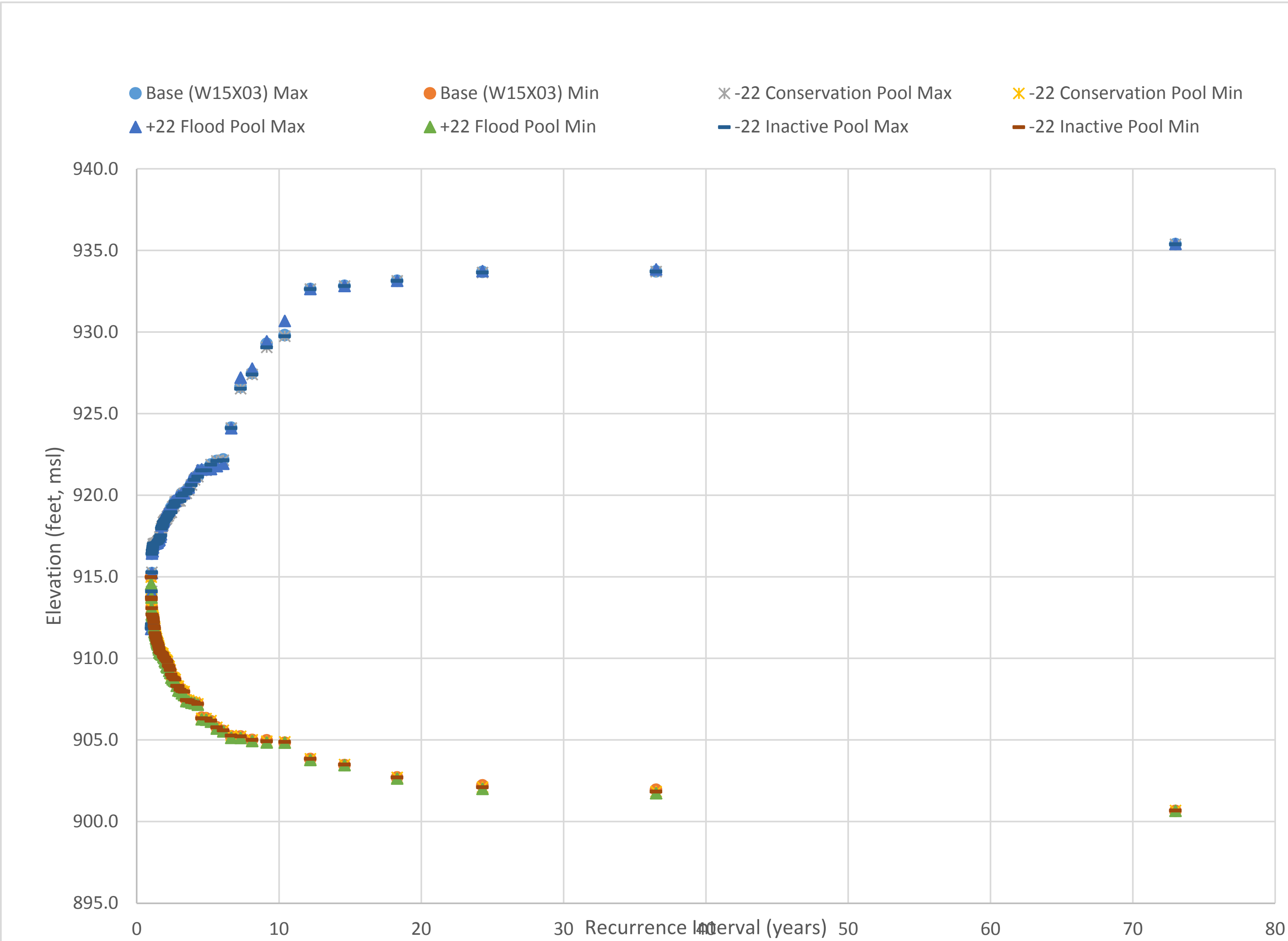


Figure 5: Table Rock Lake Elevation Frequency Curve

Table 12: Table Rock Max/Min RiverWare Pool Elevation Frequency

	Base (W15X03)				-22 Conservation Pool				+22 Flood Pool				-22 Inactive Pool				Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min		
1	1945	935.4	1964	900.6	1945	935.4	1964	900.7	1945	935.4	1964	900.7	1945	935.4	1964	900.7	0.014	73.0
2	1943	933.7	1954	901.9	1943	933.7	1954	901.8	1943	933.8	1954	901.7	1943	933.7	1954	901.8	0.027	36.5
3	2011	933.7	1955	902.2	2011	933.7	1955	902.1	2011	933.7	1955	902.0	2011	933.7	1955	902.1	0.041	24.3
4	1957	933.1	1977	902.7	1957	933.1	1977	902.7	1957	933.1	1977	902.6	1957	933.1	1977	902.7	0.055	18.3
5	2008	932.8	1981	903.5	2008	932.8	1981	903.5	2008	932.8	1981	903.5	2008	932.8	1981	903.5	0.068	14.6
6	1973	932.6	2006	903.8	1973	932.6	2006	903.8	1973	932.6	2006	903.8	1973	932.6	2006	903.8	0.082	12.2
7	1961	929.8	1965	904.8	1961	929.7	1965	904.9	1961	930.7	1979	904.8	1961	929.7	1965	904.9	0.096	10.4
8	1990	929.3	1979	905.0	1990	929.1	1979	904.9	1990	929.4	1965	904.8	1990	929.1	1979	904.9	0.110	9.13
9	1950	927.5	1956	905.0	1950	927.4	1956	905.0	1950	927.8	1956	904.9	1950	927.4	1956	905.0	0.123	8.11
10	1974	926.6	2007	905.2	1974	926.5	1967	905.2	1974	927.2	1967	905.1	1974	926.5	1967	905.2	0.137	7.30
11	1985	924.1	1967	905.2	1985	924.1	2007	905.3	1985	924.1	2007	905.1	1985	924.1	2007	905.3	0.151	6.64
12	1993	922.2	1957	905.6	1993	922.1	1957	905.6	1975	921.9	1957	905.5	1993	922.1	1957	905.6	0.164	6.08
13	2010	922.1	2000	905.8	2010	922.1	2000	905.8	1993	921.8	2000	905.7	2010	922.1	2000	905.8	0.178	5.62
14	1975	921.9	1989	906.1	1975	921.9	1989	906.2	1988	921.6	1989	906.1	1975	921.9	1989	906.2	0.192	5.21
15	1995	921.6	1966	906.3	1995	921.5	1966	906.3	1986	921.6	2011	906.2	1995	921.5	1966	906.3	0.205	4.87
16	1986	921.5	2011	906.4	1986	921.5	2011	906.3	2010	921.6	1966	906.3	1986	921.5	2011	906.3	0.219	4.56
17	1941	921.1	1976	907.2	1941	921.1	1976	907.2	1995	921.5	1976	907.2	1941	921.1	1976	907.2	0.233	4.29
18	2004	921.0	1985	907.3	2004	920.9	1985	907.3	1941	921.1	1985	907.2	2004	920.9	1985	907.3	0.247	4.06
19	1988	920.7	1984	907.3	1988	920.6	1984	907.3	2004	921.0	1984	907.3	1988	920.6	1984	907.3	0.260	3.84
20	2009	920.4	1983	907.4	2009	920.3	1983	907.4	2009	920.5	1983	907.4	2009	920.3	1983	907.4	0.274	3.65
21	2002	920.2	1953	907.5	1978	920.1	1953	907.5	2002	920.4	1953	907.4	1978	920.1	1953	907.5	0.288	3.48
22	1978	920.1	1982	908.0	2002	920.1	1948	908.0	1997	920.1	1996	907.7	2002	920.1	1948	908.0	0.301	3.32
23	1994	920.1	1948	908.0	1994	920.0	1990	908.0	1978	920.1	1948	907.9	1994	920.0	1990	908.0	0.315	3.17
24	1997	919.8	1990	908.0	1951	919.7	1982	908.1	1994	920.0	1982	908.0	1951	919.7	1982	908.1	0.329	3.04
25	1951	919.7	1963	908.3	1942	919.6	1996	908.3	1949	919.9	1990	908.0	1942	919.6	1996	908.3	0.342	2.92
26	1942	919.6	1996	908.4	1983	919.6	1963	908.3	1960	919.8	1963	908.3	1983	919.6	1963	908.3	0.356	2.81
27	1983	919.6	2002	908.7	1997	919.6	2002	908.7	1951	919.7	2003	908.6	1997	919.6	2002	908.7	0.370	2.70
28	1992	919.4	2001	908.7	1992	919.4	2001	908.8	1942	919.6	2002	908.6	1992	919.4	2001	908.8	0.384	2.61
29	1960	919.3	1980	908.8	1960	919.3	1980	908.8	1983	919.6	2001	908.7	1960	919.3	1980	908.8	0.397	2.52
30	1949	919.2	2003	909.0	1949	919.0	2003	909.0	1946	919.4	1980	908.8	1949	919.0	2003	909.0	0.411	2.43
31	1971	919.0	1972	909.3	1971	919.0	1972	909.3	1992	919.4	1944	909.1	1971	919.0	1972	909.3	0.425	2.35
32	1965	918.8	1973	909.5	1965	918.9	1973	909.5	1969	919.1	1972	909.2	1965	918.9	1973	909.5	0.438	2.28
33	1969	918.8	2004	909.6	1969	918.8	2004	909.6	1968	919.1	1973	909.4	1969	918.8	2004	909.6	0.452	2.21
34	1968	918.7	1999	909.8	1968	918.7	1999	909.8	1998	919.0	1995	909.4	1968	918.7	1999	909.8	0.466	2.15
35	2005	918.6	1978	909.9	1998	918.6	1978	909.9	1971	918.9	2004	909.5	1998	918.6	1978	909.9	0.479	2.09
36	1998	918.6	1944	910.0	2005	918.5	1944	909.9	1958	918.9	1999	909.7	2005	918.5	1944	909.9	0.493	2.03
37	1946	918.5	1995	910.0	1946	918.5	1995	910.0	1965	918.8	1978	909.8	1946	918.5	1995	910.0	0.507	1.97

	Base (W15X03)				-22 Conservation Pool				+22 Flood Pool				-22 Inactive Pool				Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min		
38	1991	918.4	2008	910.0	1991	918.4	2008	910.1	2005	918.5	2008	910.0	1991	918.4	2008	910.1	0.521	1.92
39	1976	918.3	1992	910.2	1976	918.3	1992	910.1	1991	918.4	1992	910.1	1976	918.3	1992	910.1	0.534	1.87
40	1979	918.1	1991	910.3	1979	918.2	1991	910.3	1976	918.3	1994	910.2	1979	918.2	1991	910.3	0.548	1.83
41	1958	918.1	1968	910.3	1958	918.1	1998	910.3	1947	918.3	1968	910.2	1958	918.1	1998	910.3	0.562	1.78
42	1947	918.0	1998	910.3	1947	918.0	1971	910.3	1979	918.1	1991	910.2	1947	918.0	1971	910.3	0.575	1.74
43	1999	917.5	1971	910.3	1999	917.5	1968	910.3	1999	917.6	1998	910.3	1999	917.5	1968	910.3	0.589	1.70
44	1982	917.4	1988	910.4	1982	917.4	1970	910.4	1970	917.4	1971	910.3	1982	917.4	1970	910.4	0.603	1.66
45	1970	917.4	1970	910.4	1970	917.4	1988	910.4	1982	917.4	1970	910.3	1970	917.4	1988	910.4	0.616	1.62
46	1952	917.3	2005	910.6	1952	917.3	2005	910.6	1952	917.3	1988	910.4	1952	917.3	2005	910.6	0.630	1.59
47	2007	917.2	1969	910.7	2007	917.2	1969	910.7	2007	917.2	2005	910.5	2007	917.2	1969	910.7	0.644	1.55
48	1966	917.2	1994	910.8	1966	917.2	1994	910.8	1966	917.2	1969	910.7	1966	917.2	1994	910.8	0.658	1.52
49	2001	917.2	1997	910.9	1984	917.2	1947	910.9	1984	917.2	1947	910.8	1984	917.2	1947	910.9	0.671	1.49
50	1984	917.2	1947	910.9	1948	917.1	1997	910.9	1948	917.1	1997	910.9	1948	917.1	1997	910.9	0.685	1.46
51	1948	917.1	1952	911.0	2001	917.1	1952	911.0	2001	917.1	1952	910.9	2001	917.1	1952	911.0	0.699	1.43
52	1989	917.1	1959	911.1	1989	917.1	1959	911.1	1989	917.1	1959	911.0	1989	917.1	1959	911.1	0.712	1.40
53	1962	917.1	1941	911.2	1953	917.1	1941	911.2	1953	917.1	1941	911.1	1953	917.1	1941	911.2	0.726	1.38
54	1953	917.1	1960	911.3	1944	917.1	1960	911.3	1944	917.1	1960	911.2	1944	917.1	1960	911.3	0.740	1.35
55	1944	917.1	1962	911.4	2000	917.0	1962	911.4	2000	917.0	1962	911.4	2000	917.0	1962	911.4	0.753	1.33
56	2000	917.0	1987	911.5	1955	917.0	1987	911.5	1955	917.0	1987	911.4	1955	917.0	1987	911.5	0.767	1.30
57	1955	917.0	1986	911.5	1962	917.0	1986	911.5	1962	917.0	1986	911.5	1962	917.0	1986	911.5	0.781	1.28
58	1987	917.0	1951	911.9	1987	917.0	1951	911.8	1987	917.0	1946	911.6	1987	917.0	1951	911.8	0.795	1.26
59	1956	917.0	1961	911.9	1956	917.0	1961	911.9	1959	917.0	1951	911.6	1956	917.0	1961	911.9	0.808	1.24
60	1959	917.0	1945	912.0	1959	917.0	1945	912.0	1956	917.0	1961	911.9	1959	917.0	1945	912.0	0.822	1.22
61	1980	917.0	1946	912.2	2003	917.0	1946	912.2	2003	917.0	1945	911.9	2003	917.0	1946	912.2	0.836	1.20
62	2003	917.0	1975	912.4	1980	917.0	1975	912.4	1980	917.0	1975	912.1	1980	917.0	1975	912.4	0.849	1.18
63	1996	917.0	1942	912.5	1996	917.0	1942	912.5	1996	917.0	1943	912.3	1996	917.0	1942	912.5	0.863	1.16
64	1940	916.9	1943	912.6	1940	916.9	1943	912.5	1940	916.8	1942	912.4	1940	916.9	1943	912.5	0.877	1.14
65	1972	916.8	1949	912.6	1972	916.8	1949	912.6	1972	916.8	1949	912.5	1972	916.8	1949	912.6	0.890	1.12
66	1967	916.6	1950	912.7	1967	916.7	1950	912.7	1967	916.6	1940	912.6	1967	916.7	1950	912.7	0.904	1.11
67	2006	916.6	2010	912.7	2006	916.6	2010	912.7	2006	916.5	1950	912.6	2006	916.6	2010	912.7	0.918	1.09
68	1963	916.4	1940	912.7	1963	916.4	1940	912.7	1963	916.4	2010	912.6	1963	916.4	1940	912.7	0.932	1.07
69	1981	915.2	1974	913.2	1981	915.3	1974	913.1	1981	915.2	1974	912.7	1981	915.3	1974	913.1	0.945	1.06
70	1977	914.1	2009	913.6	1977	914.1	2009	913.6	1977	914.0	2009	913.1	1977	914.1	2009	913.6	0.959	1.04
71	1964	912.1	1958	913.7	1964	912.1	1958	913.7	1964	912.1	1958	913.7	1964	912.1	1958	913.7	0.973	1.03
72	1954	912.0	1993	915.0	1954	911.9	1993	915.0	1954	911.8	1993	914.6	1954	911.9	1993	915.0	0.986	1.01

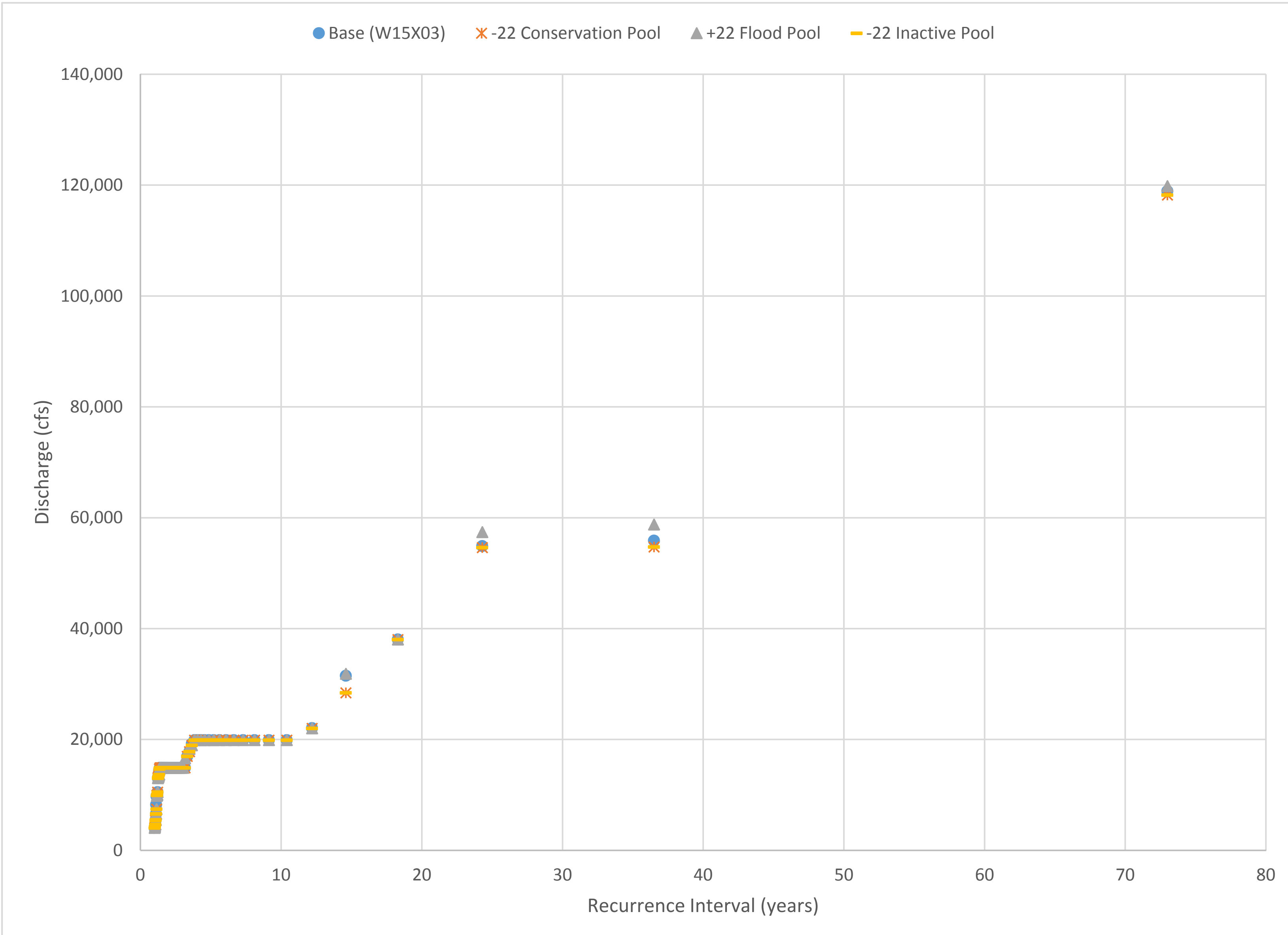


Figure 6: Table Rock Lake Outflow Frequency Curve

Table 13: Table Rock Lake Outflow Frequency

	Base (W15X03)		-22 Conservation Pool		+22 Flood Pool		-22 Inactive Pool		Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Max	Water Year	Max	Water Year	Max		
1	1945	118909	1945	118217	1945	119804	1945	118217	0.014	73.0
2	2011	55859	2011	54738	1943	58770	2011	54738	0.027	36.5
3	1943	54884	1943	54613	2011	57389	1943	54613	0.041	24.3
4	1957	38058	1957	38032	1957	38033	1957	38032	0.055	18.3
5	2008	31492	2008	28425	2008	31833	2008	28425	0.068	14.6
6	1973	22044	1973	22006	1973	22006	1973	22006	0.082	12.2
7	1961	19880	1961	19880	1961	19880	1961	19880	0.096	10.4
8	1990	19880	1990	19880	1990	19880	1990	19880	0.110	9.13
9	1950	19880	1950	19880	1950	19880	1950	19880	0.123	8.11
10	1974	19880	1974	19880	1974	19880	1974	19880	0.137	7.30
11	1985	19880	1985	19880	1985	19880	1985	19880	0.151	6.64
12	1993	19880	1993	19880	1975	19880	1993	19880	0.164	6.08
13	1975	19880	1975	19880	1993	19880	1975	19880	0.178	5.62
14	1986	19880	1986	19880	1995	19880	1986	19880	0.192	5.21
15	1995	19880	1995	19880	1986	19880	1995	19880	0.205	4.87
16	2010	19880	2010	19880	1988	19880	2010	19880	0.219	4.56
17	1941	19880	1941	19880	2004	19880	1941	19880	0.233	4.29
18	2004	19880	2004	19880	2010	19880	2004	19880	0.247	4.06
19	1988	19880	1988	19880	1941	19880	1988	19880	0.260	3.84
20	2002	19257	2002	18945	2002	18945	2002	18945	0.274	3.65
21	1978	17802	1978	17802	1997	18321	1978	17802	0.288	3.48
22	1983	16919	1983	16971	1978	17802	1983	16971	0.301	3.32
23	1994	14880	1994	14880	1983	16607	1994	14880	0.315	3.17
24	1942	14880	1942	14880	1960	14880	1942	14880	0.329	3.04
25	1946	14880	1946	14880	1946	14880	1946	14880	0.342	2.92
26	1951	14880	1951	14880	1994	14880	1951	14880	0.356	2.81
27	1960	14880	1960	14880	2009	14880	1960	14880	0.370	2.70
28	1971	14880	1971	14880	1942	14880	1971	14880	0.384	2.61
29	1992	14880	1992	14880	1949	14880	1992	14880	0.397	2.52
30	1997	14880	1997	14880	1951	14880	1997	14880	0.411	2.43
31	2009	14880	2009	14880	1958	14880	2009	14880	0.425	2.35
32	1958	14880	1958	14880	1971	14880	1958	14880	0.438	2.28
33	1969	14880	1969	14880	1992	14880	1969	14880	0.452	2.21

	Base (W15X03)		-22 Conservation Pool		+22 Flood Pool		-22 Inactive Pool		Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Max	Water Year	Max	Water Year	Max		
34	1970	14880	1970	14880	1969	14880	1970	14880	0.466	2.15
35	1976	14880	1976	14880	1970	14880	1976	14880	0.479	2.09
36	1979	14880	1979	14880	1976	14880	1979	14880	0.493	2.03
37	1999	14880	1999	14880	1979	14880	1999	14880	0.507	1.97
38	1947	14880	1947	14880	1999	14880	1947	14880	0.521	1.92
39	1952	14880	1952	14880	1947	14880	1952	14880	0.534	1.87
40	1982	14880	1982	14880	1952	14880	1982	14880	0.548	1.83
41	2007	14880	2007	14880	1982	14880	2007	14880	0.562	1.78
42	1949	14880	1949	14880	2007	14880	1949	14880	0.575	1.74
43	1965	14880	1965	14880	1968	14880	1965	14880	0.589	1.70
44	1968	14880	1968	14880	1998	14880	1968	14880	0.603	1.66
45	1998	14880	1998	14880	1965	14880	1998	14880	0.616	1.62
46	1991	14880	1991	14880	1991	14880	1991	14880	0.630	1.59
47	2005	14880	2005	14880	2005	14880	2005	14880	0.644	1.55
48	2001	14880	2001	14880	2001	14880	2001	14880	0.658	1.52
49	1984	14880	1984	14880	1984	14880	1984	14880	0.671	1.49
50	1966	14880	1966	14880	1966	14880	1966	14880	0.685	1.46
51	1989	14880	1989	14880	1989	14880	1989	14880	0.699	1.43
52	1955	14880	1955	14880	1955	14880	1955	14880	0.712	1.40
53	1940	14880	1940	14880	1940	14880	1940	14880	0.726	1.38
54	1948	14685	1948	14685	1948	14685	1948	14685	0.740	1.35
55	1972	14477	1972	13646	1972	13646	1972	13646	0.753	1.33
56	1959	13445	1959	13446	1959	13408	1959	13446	0.767	1.30
57	1953	13334	1944	13230	1953	13230	1944	13230	0.781	1.28
58	1944	13230	1953	13230	1987	13230	1953	13230	0.795	1.26
59	1987	13022	1987	13022	1944	13022	1987	13022	0.808	1.24
60	1981	10510	1981	10504	1981	10508	1981	10504	0.822	1.22
61	2000	10027	2000	10033	2000	10020	2000	10033	0.836	1.20
62	1980	9914	1956	9980	1980	9907	1956	9980	0.849	1.18
63	1956	9908	1980	9937	1956	9827	1980	9937	0.863	1.16
64	1996	9759	2003	7459	2003	7459	2003	7459	0.877	1.14
65	2003	8250	1962	6580	1962	6580	1962	6580	0.890	1.12
66	1962	6580	1996	6580	1996	6580	1996	6580	0.904	1.11
67	2006	5507	2006	5506	2006	5509	2006	5506	0.918	1.09
68	1954	5397	1954	5400	1954	5403	1954	5400	0.932	1.07

	Base (W15X03)		-22 Conservation Pool		+22 Flood Pool		-22 Inactive Pool		Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Max	Water Year	Max	Water Year	Max		
69	1967	4658	1967	4658	1967	4660	1967	4658	0.945	1.06
70	1963	4391	1963	4391	1963	4391	1963	4391	0.959	1.04
71	1977	4165	1977	4164	1977	4166	1977	4164	0.973	1.03
72	1964	4060	1964	4059	1964	4059	1964	4059	0.986	1.01

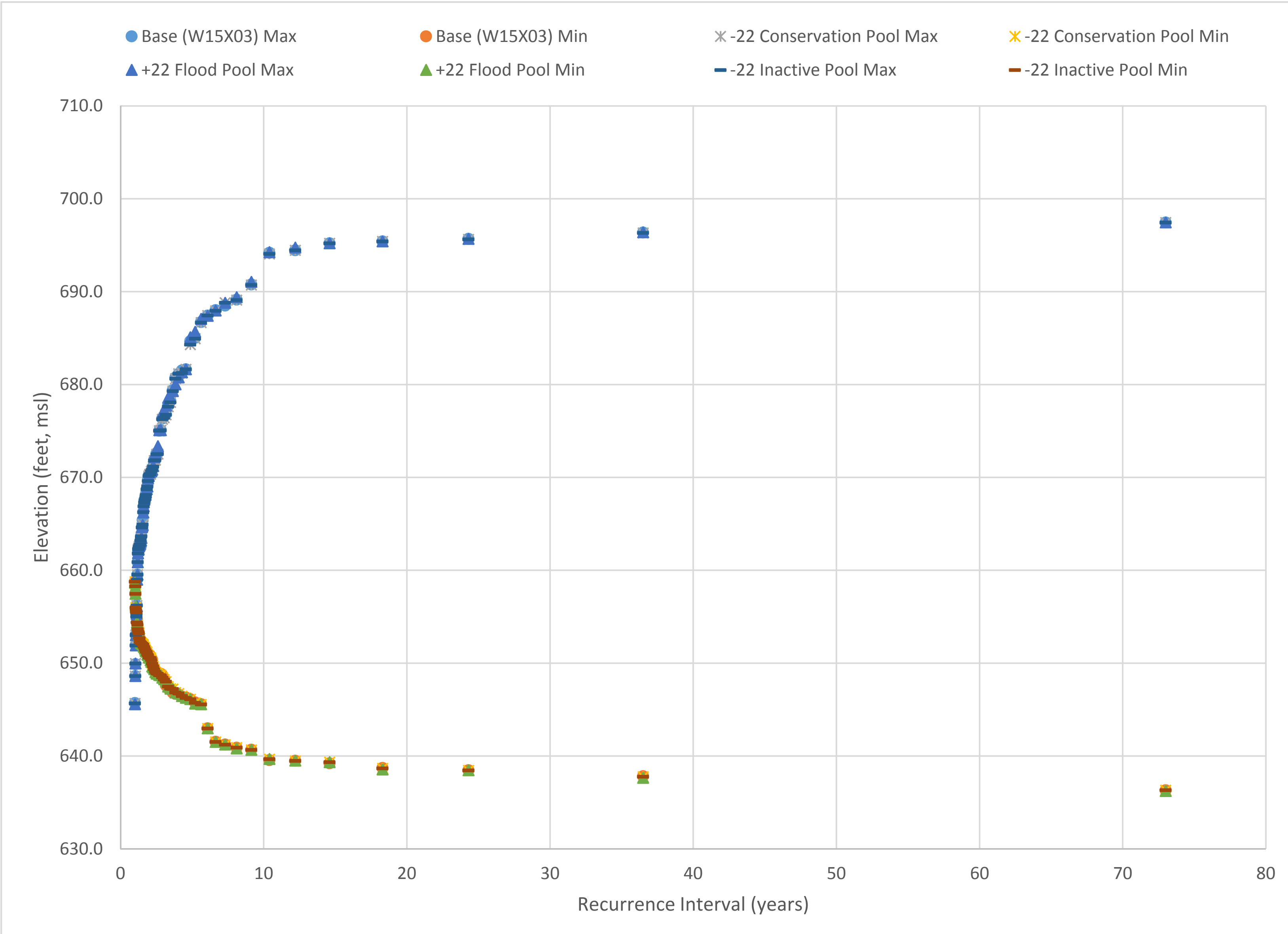


Figure 7: Bull Shoals Lake Elevation Frequency Curve

Table 14: Bull Shoals Lake Max/Min RiverWare Pool Elevation Frequency

	Base (W15X03)				-22 Conservation Pool				+22 Flood Pool				-22 Inactive Pool				Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min		
1	1945	697.5	1957	636.3	1945	697.4	1957	636.3	1945	697.5	1957	636.2	1945	697.4	1957	636.3	0.014	73.0
2	2011	696.4	1965	637.8	2011	696.3	1965	637.8	2011	696.4	1965	637.6	2011	696.3	1965	637.8	0.027	36.5
3	1957	695.7	2007	638.5	1957	695.6	2007	638.5	1957	695.7	2007	638.5	1957	695.6	2007	638.5	0.041	24.3
4	2008	695.4	1964	638.7	2008	695.4	1964	638.7	2008	695.4	1964	638.5	2008	695.4	1964	638.7	0.055	18.3
5	1973	695.2	1955	639.2	1973	695.2	1955	639.3	1973	695.2	1955	639.3	1973	695.2	1955	639.3	0.068	14.6
6	1943	694.5	2006	639.5	1943	694.5	2006	639.5	1943	694.7	2006	639.5	1943	694.5	2006	639.5	0.082	12.2
7	1990	694.2	1954	639.6	1990	694.1	1954	639.7	1990	694.3	1954	639.7	1990	694.1	1954	639.7	0.096	10.4
8	1961	690.8	2001	640.7	1961	690.7	2001	640.7	1961	691.0	2001	640.7	1961	690.7	2001	640.7	0.110	9.13
9	2002	689.1	1956	640.9	2002	689.1	1956	640.9	2002	689.4	1956	640.8	2002	689.1	1956	640.9	0.123	8.11
10	2009	688.5	1981	641.2	2009	688.8	1981	641.2	2009	688.8	1981	641.2	2009	688.8	1981	641.2	0.137	7.30
11	1950	688.0	2000	641.5	1950	687.9	2000	641.5	1950	688.0	2000	641.5	1950	687.9	2000	641.5	0.151	6.64
12	1985	687.4	1982	643.0	1985	687.4	1982	643.0	1985	687.4	1982	643.0	1985	687.4	1982	643.0	0.164	6.08
13	1974	686.7	1968	645.6	1974	686.7	1968	645.6	1974	687.1	1968	645.6	1974	686.7	1968	645.6	0.178	5.62
14	1995	685.0	1963	645.8	1995	684.9	1963	645.7	1995	685.7	1963	645.6	1995	684.9	1963	645.7	0.192	5.21
15	1979	684.7	1967	646.1	1979	684.3	1967	646.1	1979	685.1	1967	646.1	1979	684.3	1967	646.1	0.205	4.87
16	1946	681.6	2002	646.3	1946	681.6	1979	646.3	1946	681.6	1979	646.3	1946	681.6	1979	646.3	0.219	4.56
17	1951	681.5	1953	646.4	1951	681.2	1953	646.5	1951	681.3	1953	646.5	1951	681.2	1953	646.5	0.233	4.29
18	2010	681.2	1979	646.6	2010	681.2	1985	646.7	2010	680.8	1985	646.7	2010	681.2	1985	646.7	0.247	4.06
19	1994	680.7	1985	646.7	1994	680.6	2011	646.8	1994	680.0	2011	646.8	1994	680.6	2011	646.8	0.260	3.84
20	1993	679.4	2011	646.8	1993	679.3	1966	647.2	1993	679.3	1966	647.2	1993	679.3	1966	647.2	0.274	3.65
21	2004	678.2	1984	647.2	2004	678.1	1984	647.2	2004	678.6	1984	647.2	2004	678.1	1984	647.2	0.288	3.48
22	1949	677.7	1966	647.3	1949	677.6	1989	647.5	1975	678.6	1989	647.5	1949	677.6	1989	647.5	0.301	3.32
23	1986	676.8	1989	647.6	1986	676.7	2002	648.0	1949	677.7	2002	648.0	1986	676.7	2002	648.0	0.315	3.17
24	1958	676.6	1948	648.3	1958	676.4	1948	648.2	1958	677.2	1948	648.3	1958	676.4	1948	648.2	0.329	3.04
25	1975	676.3	1980	648.7	1975	676.3	1972	648.5	1986	676.9	1972	648.4	1975	676.3	1972	648.5	0.342	2.92
26	1983	675.1	1977	648.9	1983	675.1	1980	648.7	1983	675.1	1980	648.7	1983	675.1	1980	648.7	0.356	2.81
27	1991	675.0	1973	648.9	1991	675.0	1973	648.7	1991	675.1	1973	648.7	1991	675.0	1973	648.7	0.370	2.70
28	1998	672.7	1972	648.9	1988	672.5	1977	648.9	1988	673.4	1977	648.9	1988	672.5	1977	648.9	0.384	2.61
29	1988	672.6	1990	648.9	1998	672.5	1990	648.9	1998	672.9	1990	648.9	1998	672.5	1990	648.9	0.397	2.52
30	1997	671.9	1983	649.0	1997	671.9	1983	649.0	1960	672.7	1983	649.0	1997	671.9	1983	649.0	0.411	2.43
31	1960	671.9	1988	649.5	1960	671.8	1988	649.3	1997	672.2	1988	649.3	1960	671.8	1988	649.3	0.425	2.35
32	1947	671.2	2005	649.7	1947	671.2	2005	649.6	1947	671.2	2004	649.5	1947	671.2	2005	649.6	0.438	2.28
33	1992	670.8	1971	650.4	1992	670.8	2004	650.0	1992	670.8	2005	649.7	1992	670.8	2004	650.0	0.452	2.21
34	1966	670.7	2004	650.5	1966	670.7	1971	650.3	1966	670.7	2003	650.1	1966	670.7	1971	650.3	0.466	2.15
35	1969	670.5	1952	650.5	1984	670.4	2003	650.6	1969	670.6	1971	650.3	1984	670.4	2003	650.6	0.479	2.09
36	1984	670.4	1999	650.9	1969	670.4	1952	650.6	1984	670.6	1952	650.6	1969	670.4	1952	650.6	0.493	2.03
37	1952	670.2	1978	650.9	1952	670.2	1978	650.6	1952	670.2	1978	650.6	1952	670.2	1978	650.6	0.507	1.97

	Base (W15X03)				-22 Conservation Pool				+22 Flood Pool				-22 Inactive Pool				Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min	Water Year	Max	Water Year	Min		
38	1978	669.7	1945	650.9	1978	669.6	1999	650.9	1978	669.9	1999	650.9	1978	669.6	1999	650.9	0.521	1.92
39	1970	669.0	2003	651.1	1970	669.0	1945	650.9	1970	669.0	1945	650.9	1970	669.0	1945	650.9	0.534	1.87
40	1976	668.7	2008	651.3	1976	668.7	2008	651.2	1976	668.7	2008	651.2	1976	668.7	2008	651.2	0.548	1.83
41	1942	668.2	1947	651.3	1942	668.1	1947	651.2	1999	668.4	1947	651.3	1942	668.1	1947	651.2	0.562	1.78
42	1999	667.9	1941	651.4	1999	667.8	1941	651.4	1942	668.1	1941	651.4	1999	667.8	1941	651.4	0.575	1.74
43	2005	667.6	1998	651.6	2005	667.6	1998	651.5	1968	668.0	1998	651.6	2005	667.6	1998	651.5	0.589	1.70
44	1968	667.4	1996	651.7	1968	667.3	1996	651.7	2005	667.6	1996	651.7	1968	667.3	1996	651.7	0.603	1.66
45	1941	666.9	1940	651.8	1941	666.9	1940	651.8	1941	666.9	1940	651.8	1941	666.9	1940	651.8	0.616	1.62
46	1948	666.3	1960	652.0	1948	666.3	1960	652.0	1948	666.2	1960	652.0	1948	666.3	1960	652.0	0.630	1.59
47	1972	665.4	1959	652.0	1972	664.9	1959	652.0	1972	664.9	1959	652.0	1972	664.9	1959	652.0	0.644	1.55
48	1953	664.7	1943	652.1	1953	664.6	1961	652.1	1953	664.8	1943	652.1	1953	664.6	1961	652.1	0.658	1.52
49	1971	664.6	1944	652.1	1971	664.6	1943	652.1	1971	664.6	1944	652.1	1971	664.6	1943	652.1	0.671	1.49
50	1989	663.7	1961	652.1	1940	663.7	1944	652.1	1989	663.5	1961	652.1	1940	663.7	1944	652.1	0.685	1.46
51	1940	663.7	1997	652.2	1989	663.6	1997	652.2	1959	663.2	1997	652.2	1989	663.6	1997	652.2	0.699	1.43
52	1959	663.2	1942	652.3	1959	663.2	1942	652.3	1940	663.1	1942	652.2	1959	663.2	1942	652.3	0.712	1.40
53	1955	662.9	1976	652.4	1962	662.8	1976	652.3	1944	662.9	1995	652.6	1962	662.8	1976	652.3	0.726	1.38
54	1962	662.8	1995	652.4	1944	662.8	1995	652.3	1962	662.8	1986	652.7	1944	662.8	1995	652.3	0.740	1.35
55	1944	662.8	1986	652.7	1982	662.7	1986	652.7	2003	662.7	1970	652.7	1982	662.7	1986	652.7	0.753	1.33
56	1982	662.7	1970	652.7	1955	662.6	1970	652.7	1955	662.6	1976	653.1	1955	662.6	1970	652.7	0.767	1.30
57	2003	662.7	1962	653.2	2003	662.4	1962	653.2	1982	662.6	1962	653.1	2003	662.4	1962	653.2	0.781	1.28
58	1965	662.5	1992	653.4	1996	662.4	1969	653.3	1965	662.3	1969	653.3	1996	662.4	1969	653.3	0.795	1.26
59	1996	662.3	1987	653.4	1965	662.3	1992	653.4	1996	662.2	1992	653.4	1965	662.3	1992	653.4	0.808	1.24
60	2007	661.9	1969	653.4	2007	661.8	1987	653.4	2007	661.8	1987	653.4	2007	661.8	1987	653.4	0.822	1.22
61	1987	660.9	1994	653.8	1987	660.9	1994	653.7	1987	660.9	1994	653.9	1987	660.9	1994	653.7	0.836	1.20
62	1980	659.5	1950	654.1	1980	659.5	1950	654.1	1980	659.5	1950	654.1	1980	659.5	1950	654.1	0.849	1.18
63	2001	659.0	1991	654.4	2001	659.0	1949	654.3	2001	659.0	1949	654.3	2001	659.0	1949	654.3	0.863	1.16
64	1963	656.2	1949	654.4	1963	656.2	1991	654.4	1963	656.1	1991	654.4	1963	656.2	1991	654.4	0.877	1.14
65	1977	655.3	1946	655.5	1977	655.3	1975	655.5	1977	655.3	2010	655.5	1977	655.3	1975	655.5	0.890	1.12
66	1956	655.0	2010	655.5	1956	655.0	1946	655.5	1956	655.0	1993	655.8	1956	655.0	1946	655.5	0.904	1.11
67	2000	653.1	1975	655.6	2000	653.1	2010	655.5	2006	653.0	1951	655.8	2000	653.1	2010	655.5	0.918	1.09
68	2006	653.0	1993	655.9	2006	653.0	1993	655.8	2000	653.0	1975	656.1	2006	653.0	1993	655.8	0.932	1.07
69	1967	651.9	1951	656.0	1967	651.9	1951	656.0	1967	651.9	1946	656.1	1967	651.9	1951	656.0	0.945	1.06
70	1954	649.9	1958	657.4	1954	650.0	1958	657.5	1954	650.0	1958	657.5	1954	650.0	1958	657.5	0.959	1.04
71	1981	648.6	2009	658.3	1981	648.6	2009	658.3	1981	648.6	2009	658.2	1981	648.6	2009	658.3	0.973	1.03
72	1964	645.7	1974	658.8	1964	645.7	1974	658.8	1964	645.6	1974	658.7	1964	645.7	1974	658.8	0.986	1.01

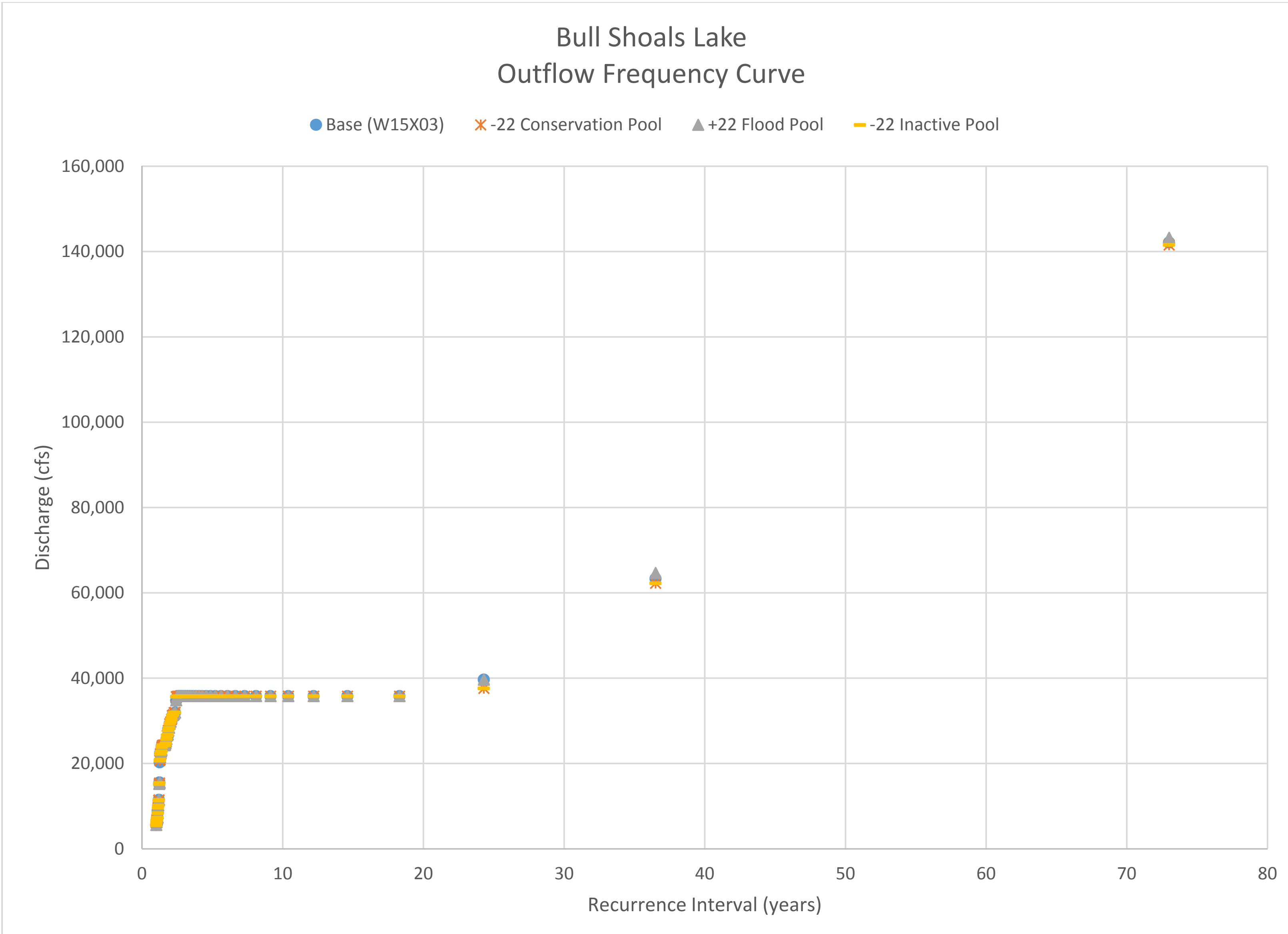


Figure 8: Bull Shoals Lake Outflow Frequency Curve

Table 15: Bull Shoals Outflow Frequency

	Base (W15X03)		-22 Conservation Pool		+22 Flood Pool		-22 Inactive Pool		Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Max	Water Year	Max	Water Year	Max		
1	1945	142134	1945	141555	1945	143245	1945	141555	0.014	73.0
2	2011	63302	2011	62257	2011	64652	2011	62257	0.027	36.5
3	1957	39653	1957	37639	1957	39634	1957	37639	0.041	24.3
4	1949	35790	1974	35790	1949	35790	1974	35790	0.055	18.3
5	1950	35790	1975	35790	1950	35790	1975	35790	0.068	14.6
6	1974	35790	1985	35790	1974	35790	1985	35790	0.082	12.2
7	1975	35790	1994	35790	1975	35790	1994	35790	0.096	10.4
8	1985	35790	1942	35790	1985	35790	1942	35790	0.110	9.13
9	1942	35790	1943	35790	1994	35790	1943	35790	0.123	8.11
10	1943	35790	1946	35790	1942	35790	1946	35790	0.137	7.30
11	1946	35790	1947	35790	1943	35790	1947	35790	0.151	6.64
12	1947	35790	1949	35790	1946	35790	1949	35790	0.164	6.08
13	1951	35790	1950	35790	1947	35790	1950	35790	0.178	5.62
14	1952	35790	1951	35790	1951	35790	1951	35790	0.192	5.21
15	1968	35790	1952	35790	1952	35790	1952	35790	0.205	4.87
16	1969	35790	1968	35790	1968	35790	1968	35790	0.219	4.56
17	1971	35790	1969	35790	1969	35790	1969	35790	0.233	4.29
18	1978	35790	1971	35790	1971	35790	1971	35790	0.247	4.06
19	1983	35790	1978	35790	1978	35790	1978	35790	0.260	3.84
20	1986	35790	1983	35790	1983	35790	1983	35790	0.274	3.65
21	1988	35790	1986	35790	1986	35790	1986	35790	0.288	3.48
22	1989	35790	1988	35790	1988	35790	1988	35790	0.301	3.32
23	1990	35790	1989	35790	1989	35790	1989	35790	0.315	3.17
24	1991	35790	1990	35790	1990	35790	1990	35790	0.329	3.04
25	1993	35790	1991	35790	1991	35790	1991	35790	0.342	2.92
26	1994	35790	1993	35790	1993	35790	1993	35790	0.356	2.81
27	1997	35790	1997	35790	1997	35790	1997	35790	0.370	2.70
28	2005	35790	2005	35790	2005	35790	2005	35790	0.384	2.61
29	2009	35790	2009	35790	2009	35790	2009	35790	0.397	2.52
30	2010	34709	2010	35682	2010	34809	2010	35682	0.411	2.43
31	1984	31915	1998	31975	1984	31915	1998	31975	0.425	2.35
32	1998	31531	1984	31915	1958	31607	1984	31915	0.438	2.28
33	2008	31281	1958	31446	1998	31398	1958	31446	0.452	2.21

	Base (W15X03)		-22 Conservation Pool		+22 Flood Pool		-22 Inactive Pool		Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Max	Water Year	Max	Water Year	Max		
34	1958	31121	2008	31230	2008	31257	2008	31230	0.466	2.15
35	2002	30383	2002	30360	2002	30737	2002	30360	0.479	2.09
36	1999	29686	1999	29737	1999	29792	1999	29737	0.493	2.03
37	1973	29324	1973	29325	1973	29325	1973	29325	0.507	1.97
38	1995	28356	1995	28373	1995	28366	1995	28373	0.521	1.92
39	1955	28033	1992	27804	1992	27711	1992	27804	0.534	1.87
40	1941	26462	1961	26777	1941	26798	1961	26777	0.548	1.83
41	1961	26298	1941	26574	1961	26626	1941	26574	0.562	1.78
42	1992	25566	1955	25720	1955	25735	1955	25720	0.575	1.74
43	1953	24719	1953	24739	1960	25251	1953	24739	0.589	1.70
44	1987	24324	1987	24324	1953	24740	1987	24324	0.603	1.66
45	1976	24320	1976	24320	1987	24324	1976	24320	0.616	1.62
46	1948	24320	1948	24320	1948	24320	1948	24320	0.630	1.59
47	1972	24312	1972	24314	1976	24320	1972	24314	0.644	1.55
48	2004	24299	2004	24300	1972	24314	2004	24300	0.658	1.52
49	1960	24292	1960	24292	2004	24298	1960	24292	0.671	1.49
50	1979	24286	1979	24287	1979	24286	1979	24287	0.685	1.46
51	1944	24212	1959	24111	1982	24267	1959	24111	0.699	1.43
52	1959	24055	1944	23834	1959	24142	1944	23834	0.712	1.40
53	2003	23137	1966	22846	1944	23171	1966	22846	0.726	1.38
54	1966	22847	1982	22723	1966	22846	1982	22723	0.740	1.35
55	1982	22707	1970	22432	1970	22452	1970	22432	0.753	1.33
56	1970	22432	1965	22266	1965	22229	1965	22266	0.767	1.30
57	1965	22266	2003	20913	2003	21498	2003	20913	0.781	1.28
58	1940	20268	1940	20721	1940	15505	1940	20721	0.795	1.26
59	2007	15551	2007	15432	2007	15337	2007	15432	0.808	1.24
60	1962	15196	1962	15192	1962	15192	1962	15192	0.822	1.22
61	1956	11496	1956	11495	1956	11500	1956	11495	0.836	1.20
62	1980	11344	1980	11344	1980	11344	1980	11344	0.849	1.18
63	2000	10153	2000	10154	2000	10154	2000	10154	0.863	1.16
64	2006	9670	2006	9671	2006	9670	2006	9671	0.877	1.14
65	2001	8992	1996	8366	1996	8351	1996	8366	0.890	1.12
66	1996	8366	2001	7318	2001	7317	2001	7318	0.904	1.11
67	1963	7263	1963	7265	1963	7268	1963	7265	0.918	1.09
68	1954	6940	1954	6937	1954	6936	1954	6937	0.932	1.07

	Base (W15X03)		-22 Conservation Pool		+22 Flood Pool		-22 Inactive Pool		Weibull plotting position	RI (years)
rank	Water Year	Max	Water Year	Max	Water Year	Max	Water Year	Max		
69	1981	6932	1981	6932	1981	6932	1981	6932	0.945	1.06
70	1977	6630	1977	6630	1977	6630	1977	6630	0.959	1.04
71	1964	6227	1964	6229	1964	6232	1964	6229	0.973	1.03
72	1967	5575	1967	5576	1967	5576	1967	5576	0.986	1.01

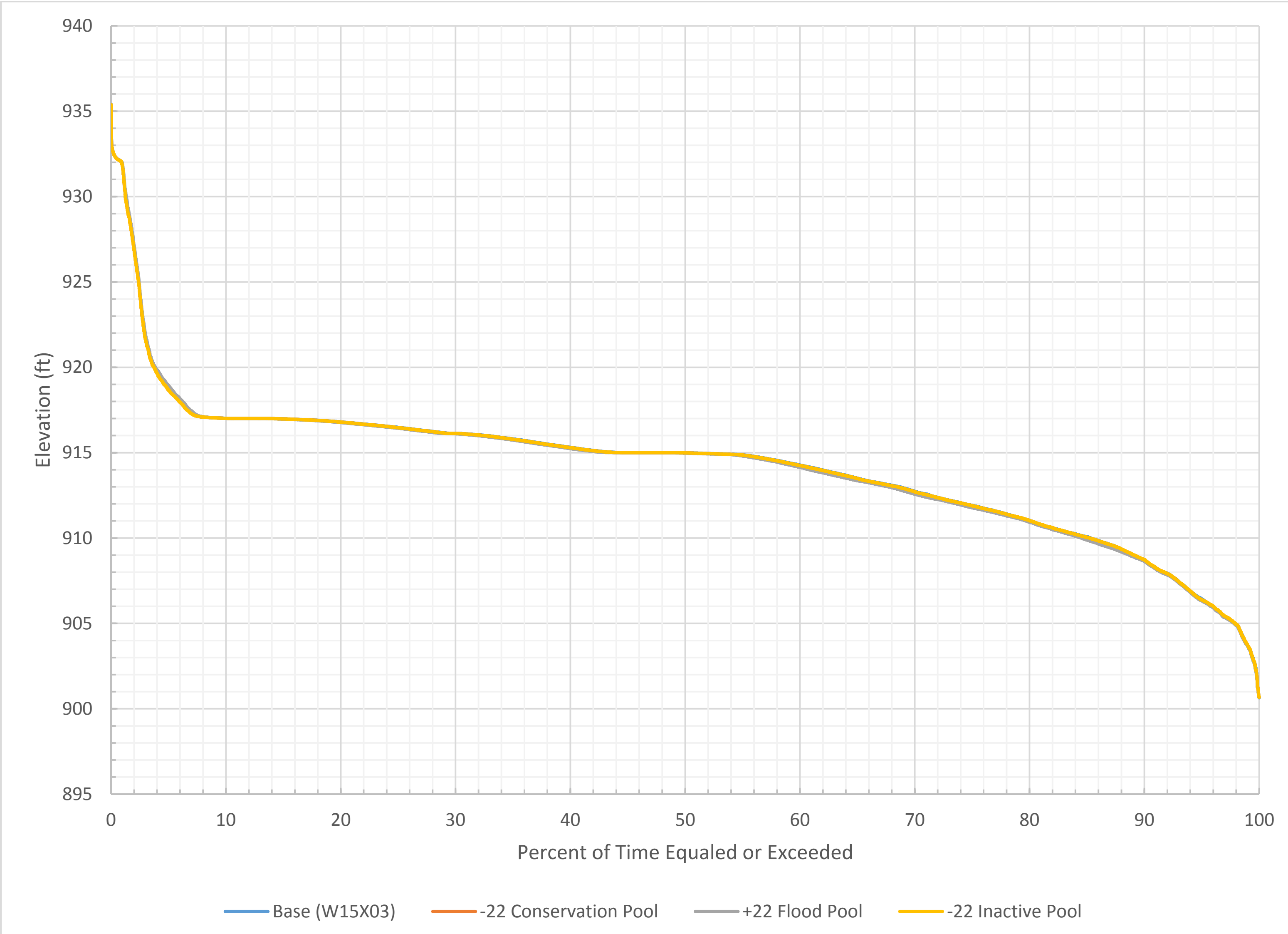


Figure 9: Table Rock Lake Pool Elevation Duration Curve

Table 16: Table Rock Lake Elevation Duration

Annual Pool Elevation - Duration					Differences in Annual Pool Elevation (Alternative minus Base)		
Percent Equaled or Exceeded	Base (W15X03)	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool
1	931.79	931.76	931.82	931.76	-0.03	0.03	-0.03
2	926.95	926.90	927.10	926.90	-0.04	0.16	-0.04
5	918.70	918.67	918.94	918.67	-0.03	0.24	-0.03
10	917.01	917.01	917.01	917.01	0.00	0.00	0.00
15	916.97	916.97	916.96	916.97	0.00	-0.01	0.00
20	916.79	916.79	916.76	916.79	-0.01	-0.03	-0.01
25	916.47	916.46	916.43	916.46	-0.01	-0.04	-0.01
30	916.12	916.12	916.11	916.12	0.00	-0.02	0.00
35	915.80	915.78	915.74	915.78	-0.02	-0.06	-0.02
40	915.30	915.29	915.24	915.29	-0.01	-0.06	-0.01
45	915.00	915.00	915.00	915.00	0.00	0.00	0.00
50	914.99	914.98	914.97	914.98	-0.01	-0.02	-0.01
55	914.87	914.85	914.81	914.85	-0.01	-0.06	-0.01
60	914.26	914.24	914.14	914.24	-0.02	-0.12	-0.02
65	913.50	913.49	913.36	913.49	-0.01	-0.14	-0.01
70	912.73	912.71	912.58	912.71	-0.01	-0.15	-0.01
75	911.90	911.89	911.77	911.89	-0.01	-0.13	-0.01
80	911.03	911.02	910.93	911.02	-0.01	-0.10	-0.01
85	910.07	910.04	909.89	910.04	-0.03	-0.18	-0.03
90	908.72	908.72	908.64	908.72	0.00	-0.08	0.00
95	906.42	906.39	906.33	906.39	-0.04	-0.10	-0.04
100	900.65	900.68	900.66	900.68	0.03	0.01	0.03

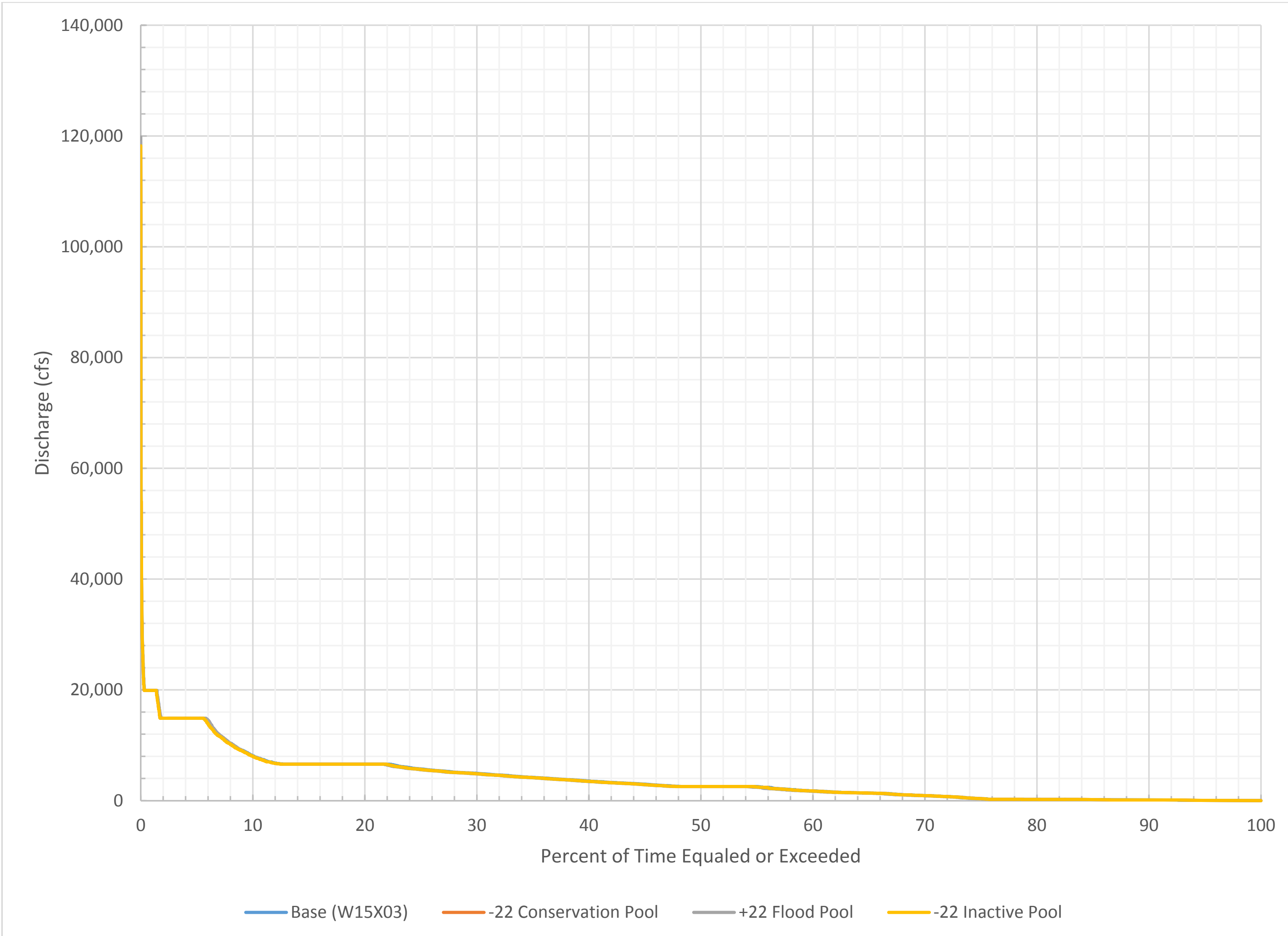


Figure 10: Table Rock Lake Outflow Duration Curve

Table 17: Table Rock Lake Outflow Duration

Annual Outflow - Duration					Differences in Annual Outflow (Alternative minus Base)		
Percent Equaled or Exceeded	Base (W15X03)	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool
1	19880	19880	19880	19880	0	0	0
2	14880	14880	14880	14880	0	0	0
5	14880	14880	14880	14880	0	0	0
10	8076	8003	8036	8003	-73	-40	-73
15	6580	6580	6580	6580	0	0	0
20	6580	6580	6580	6580	0	0	0
25	5710	5636	5572	5636	-73	-137	-73
30	4916	4843	4809	4843	-73	-107	-73
35	4186	4146	4114	4146	-40	-72	-40
40	3535	3475	3438	3475	-60	-97	-60
45	2954	2895	2852	2895	-59	-102	-59
50	2551	2550	2550	2550	-1	0	-1
55	2529	2457	2395	2457	-72	-134	-72
60	1762	1728	1670	1728	-34	-92	-34
65	1369	1356	1336	1356	-13	-33	-13
70	904	889	876	889	-15	-28	-15
75	354	348	316	348	-7	-38	-7
80	208	207	207	207	0	-1	0
85	176	174	170	174	-2	-6	-2
90	118	100	116	100	-17	-1	-17
95	44	44	43	44	-1	-1	-1
100	0	0	0	0	0	0	0

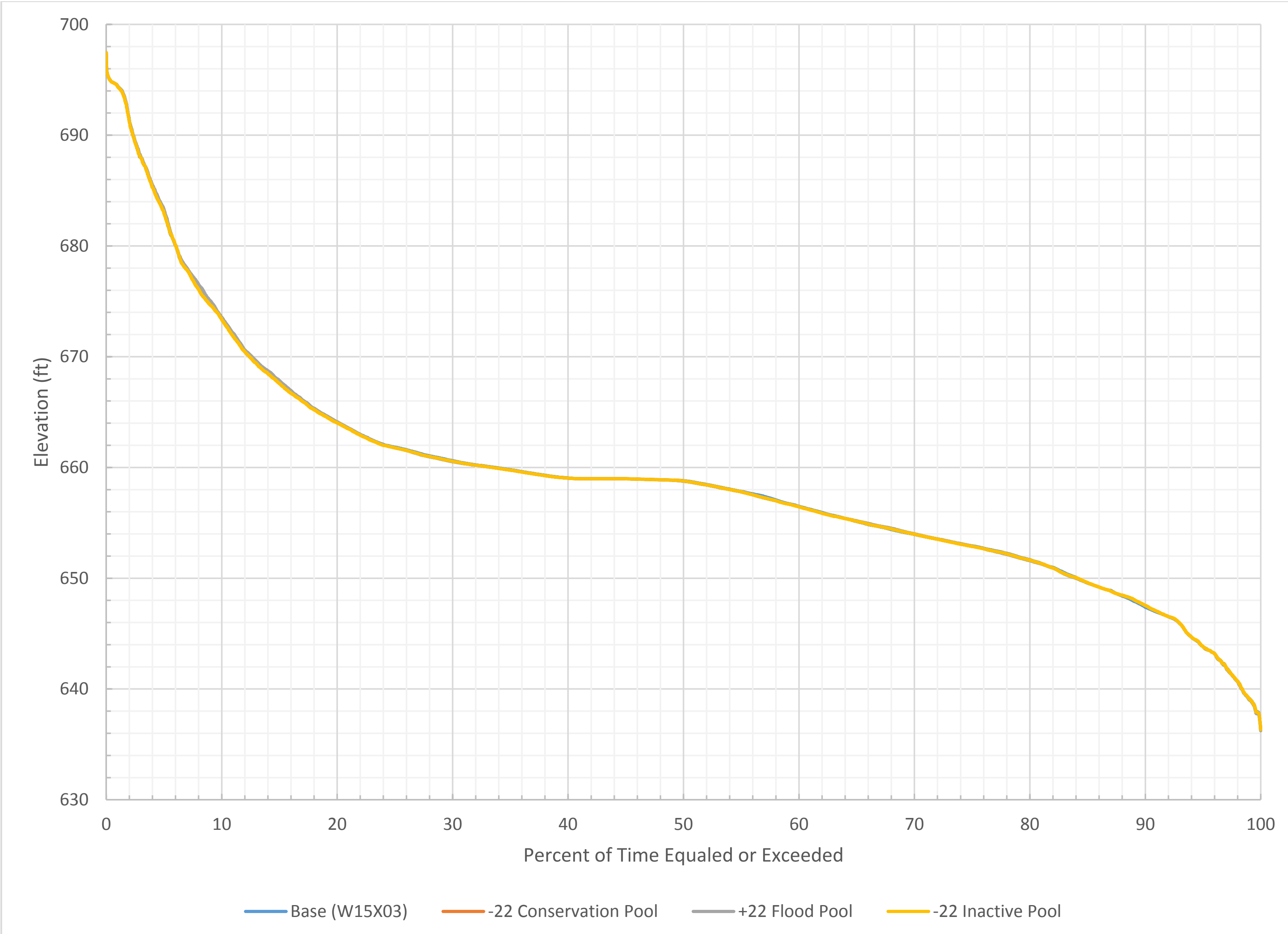


Figure 11: Bull Shoals Lake Pool Elevation Duration Curve

Table 18: Bull Shoals Lake Elevation Duration

Annual Pool Elevation - Duration					Differences in Annual Pool Elevation (Alternative minus Base)		
Percent Equaled or Exceeded	Base (W15X03)	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool
1	694.39	694.37	694.40	694.37	-0.03	0.01	-0.03
2	691.31	691.24	691.39	691.24	-0.07	0.07	-0.07
5	683.10	682.93	683.29	682.93	-0.17	0.20	-0.17
10	673.39	673.36	673.54	673.36	-0.03	0.15	-0.03
15	667.63	667.59	667.82	667.59	-0.04	0.19	-0.04
20	664.04	664.02	664.11	664.02	-0.03	0.07	-0.03
25	661.82	661.77	661.77	661.77	-0.05	-0.05	-0.05
30	660.60	660.56	660.52	660.56	-0.04	-0.08	-0.04
35	659.79	659.75	659.75	659.75	-0.03	-0.03	-0.03
40	659.05	659.03	659.02	659.03	-0.02	-0.03	-0.02
45	658.98	658.98	658.97	658.98	0.00	-0.01	0.00
50	658.80	658.78	658.75	658.78	-0.02	-0.05	-0.02
55	657.83	657.81	657.79	657.81	-0.02	-0.04	-0.02
60	656.48	656.44	656.46	656.44	-0.04	-0.02	-0.04
65	655.12	655.14	655.17	655.14	0.02	0.05	0.02
70	653.96	653.97	654.00	653.97	0.01	0.04	0.01
75	652.91	652.87	652.90	652.87	-0.04	-0.01	-0.04
80	651.66	651.63	651.59	651.63	-0.03	-0.07	-0.03
85	649.57	649.59	649.58	649.59	0.02	0.01	0.02
90	647.39	647.53	647.53	647.53	0.15	0.15	0.15
95	643.83	643.83	643.82	643.83	0.00	-0.01	0.00
100	636.32	636.33	636.23	636.33	0.01	-0.08	0.01

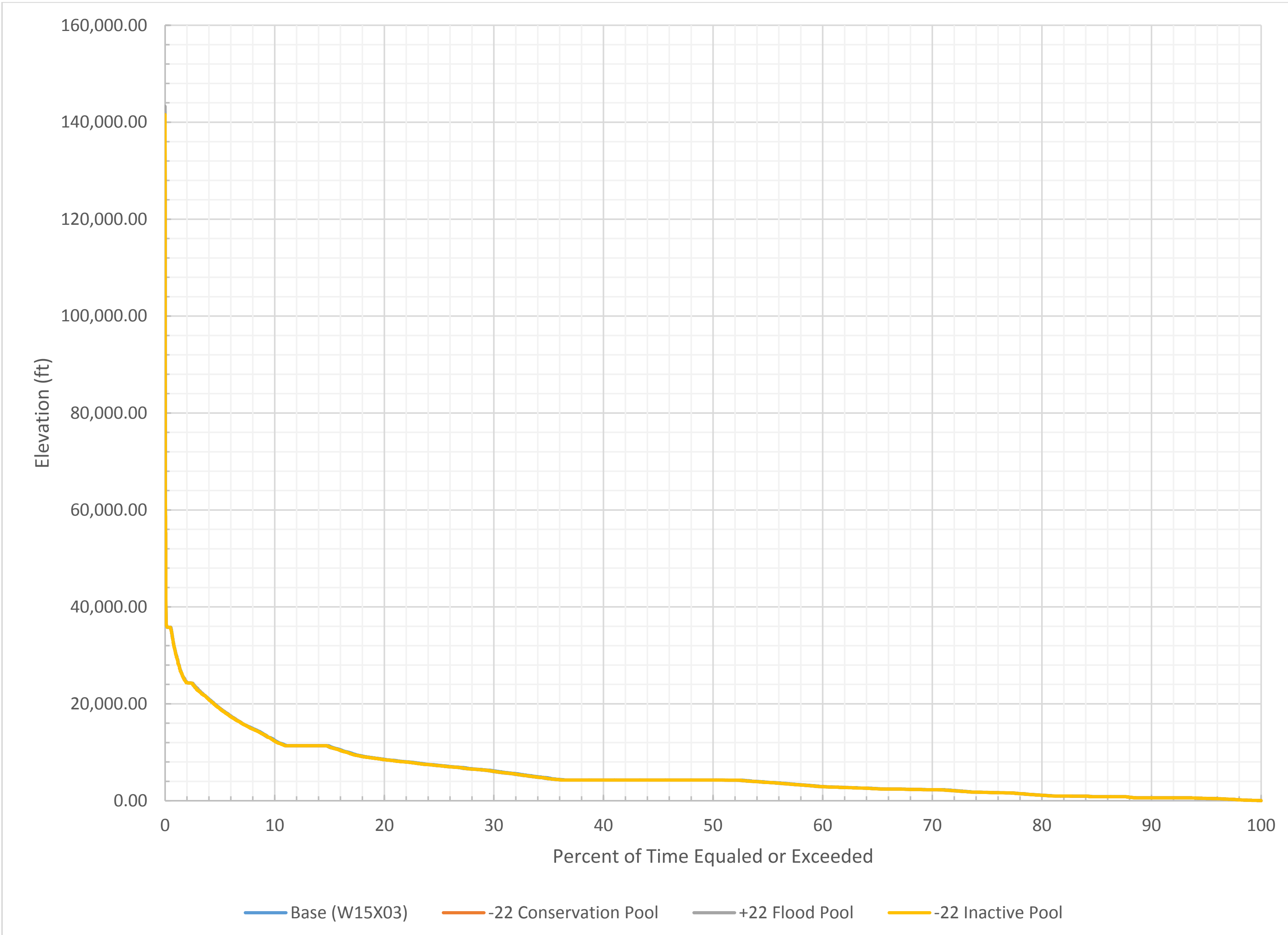


Figure 12: Bull Shoals Lake Outflow Duration Curve

Table 19: Bull Shoals Lake Outflow Duration

Annual Outflow - Duration					Differences in Annual Outflow (Alternative minus Base)		
Percent Equaled or Exceeded	Base (W15X03)	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool	-22 Conservation Pool	+22 Flood Pool	-22 Inactive Pool
1	30195	30129	30180	30129	-67	-15	-67
2	24323	24320	24446	24320	-4	123	-4
5	19030	18982	19104	18982	-48	73	-48
10	12464	12314	12354	12314	-151	-110	-151
15	11255	11127	11040	11127	-128	-215	-128
20	8525	8459	8446	8459	-65	-79	-65
25	7293	7225	7206	7225	-68	-87	-68
30	6155	6061	5995	6061	-94	-160	-94
35	4662	4555	4517	4555	-107	-145	-107
40	4259	4259	4259	4259	0	0	0
45	4257	4256	4256	4256	0	0	0
50	4252	4252	4251	4252	0	-1	0
55	3801	3764	3758	3764	-36	-43	-36
60	2922	2895	2877	2895	-27	-45	-27
65	2490	2453	2439	2453	-37	-51	-37
70	2264	2264	2264	2264	0	0	0
75	1711	1707	1705	1707	-4	-6	-4
80	1147	1125	1080	1125	-21	-67	-21
85	835	835	835	835	0	0	0
90	590	590	590	590	0	0	0
95	471	472	474	472	1	3	1
100	19	19	19	19	0	0	0