

RIVERWARE APPLICATIONS: USACE - TULSA DISTRICT

John Daylor PE, CFM

2013 RiverWare User Meeting



US Army Corps of Engineers
BUILDING STRONG[®]



RIVERWARE Tulsa District Corps?

- **Complex Reservoirs & System Operational Management
(50 Multi-Purpose Reservoirs with Common Regulation Points)**
- **Existing Reservoir & System Operational Plan**
- **Competing Interests**
- **Investigate Proposed Alternative Operation(s) With
RiverWare**
- **Evaluate Results**



Flood Control & Hydropower



Navigation



M&I Diversion



Recreation



Instream Flow



3/1/2000 1:50pm

Fish and Wildlife

Interior Least Terns



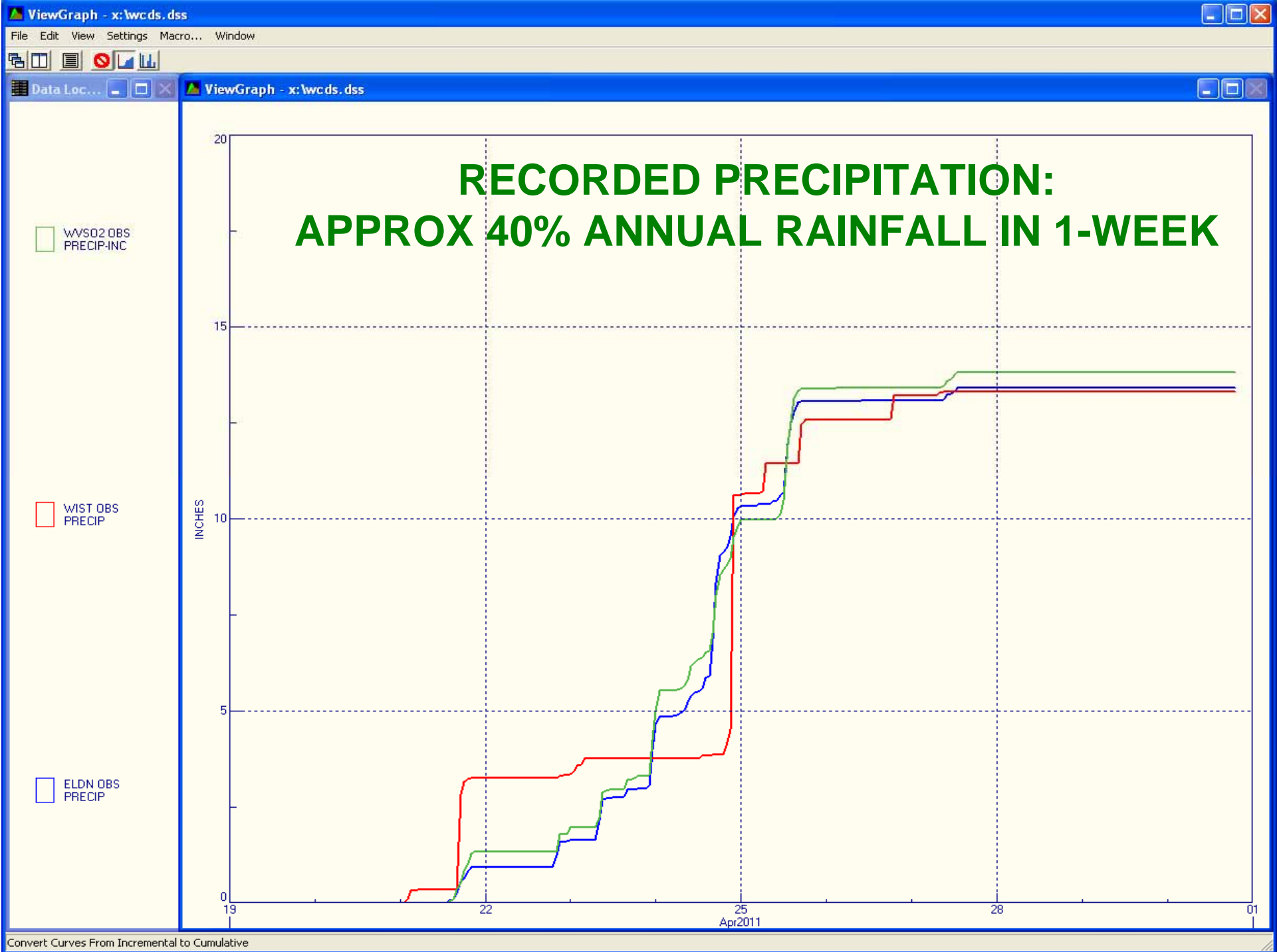
Competing Purposes & Interests

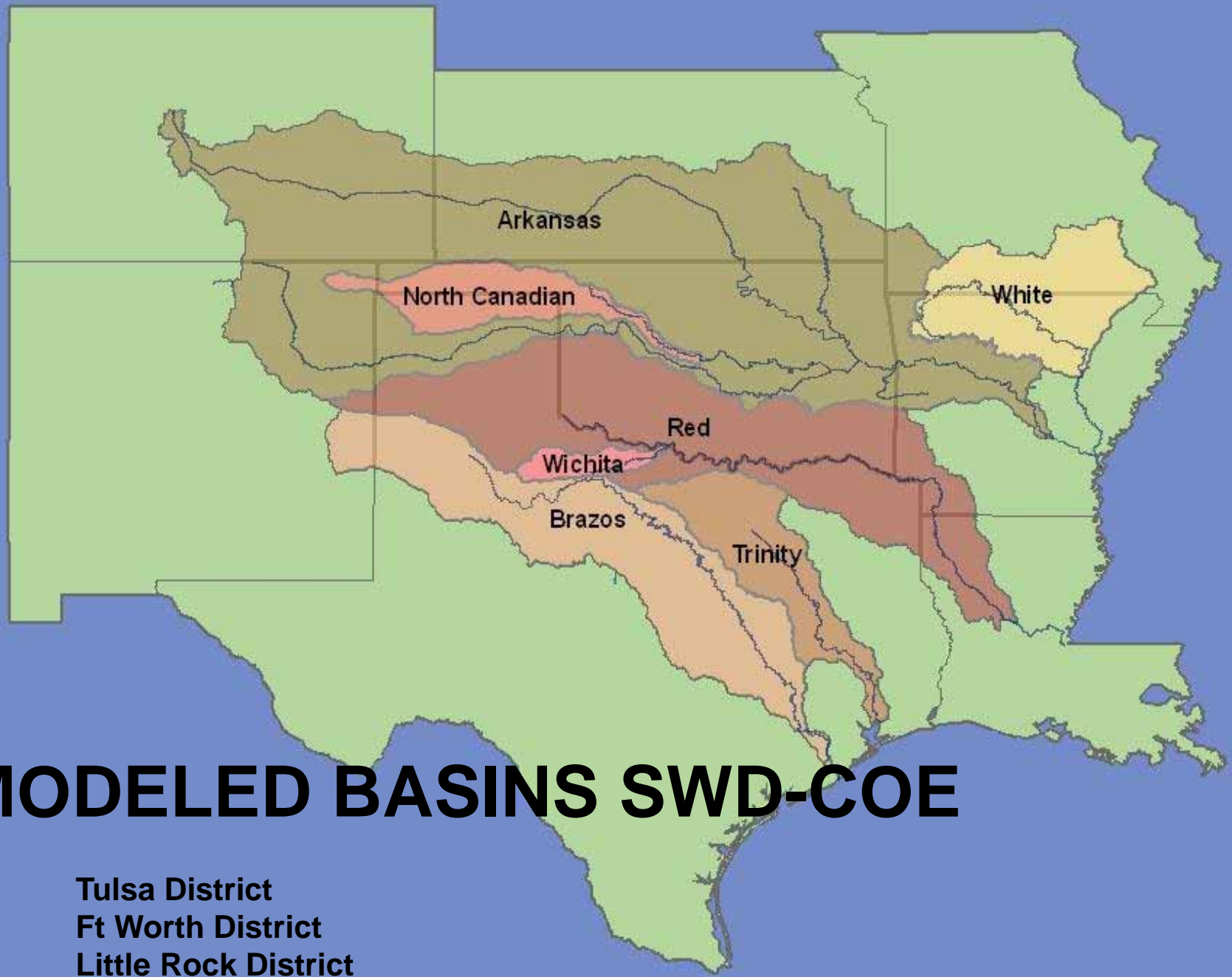


Authorized Purposes vs Political Interests



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MODELED BASINS SWD-COE

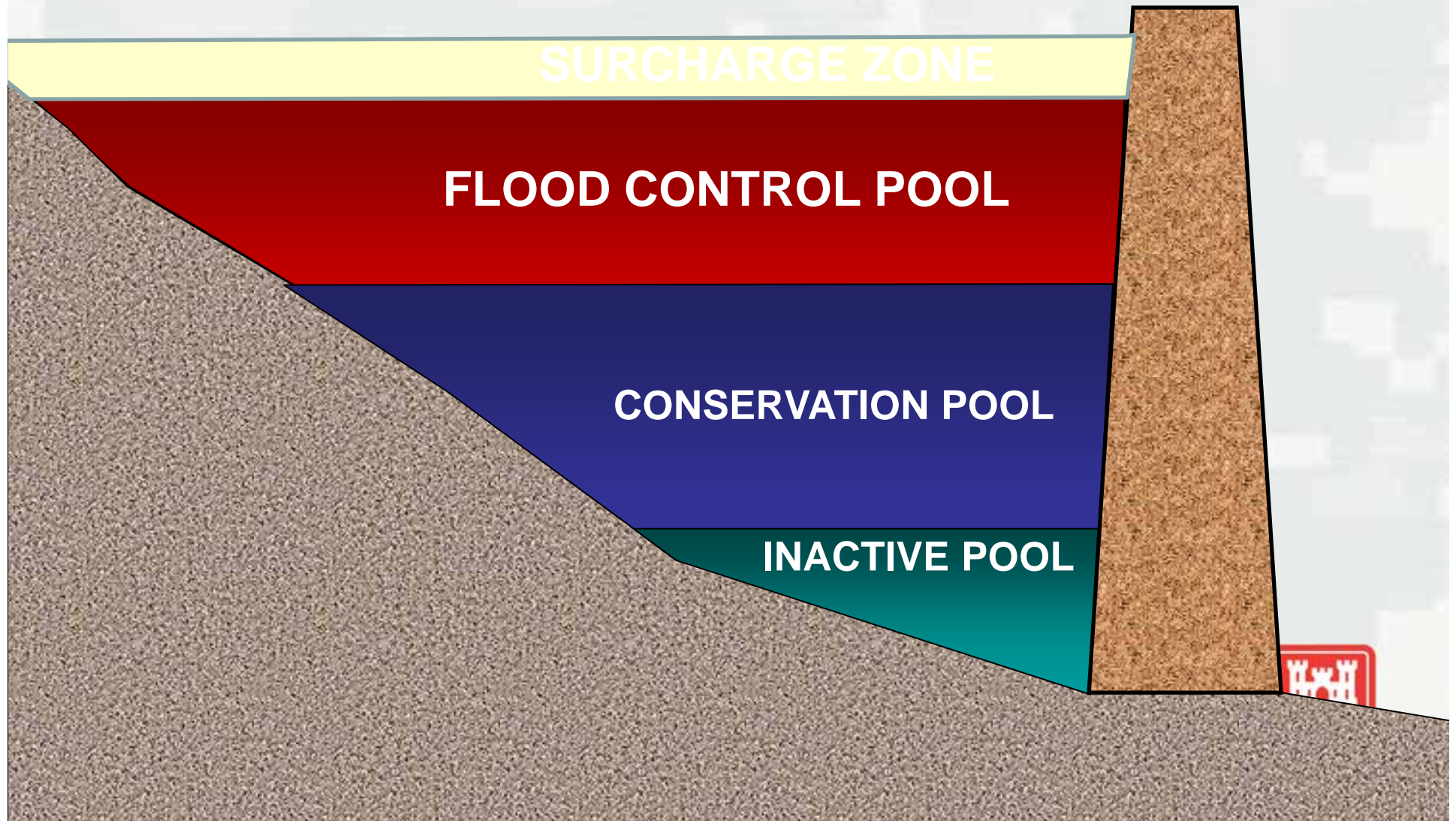
- Tulsa District
- Ft Worth District
- Little Rock District

STUDY APPROACH WITH RIVERWARE:

- Period of Record Rules Simulation: Daily Time Step
- CoE SWD Flood Control Method
- Base Condition Run: **“Replicates Existing Reservoir & System Regulation Criteria”**
- Alternative Run Depicting Proposed Operation
- Post Processing for Evaluation



Typical Operational Zones



Period of Record Rules Simulation:

- **Local Flow From Historic Hydrology**
- **Surcharge Routine**
- **Downstream Control Point Determination**
- **Reservoir Release Determination**



CONSERVATION POOL OPERATIONS:

- **Low Flow**
- **Reservoir Diversions**
- **Hydropower**





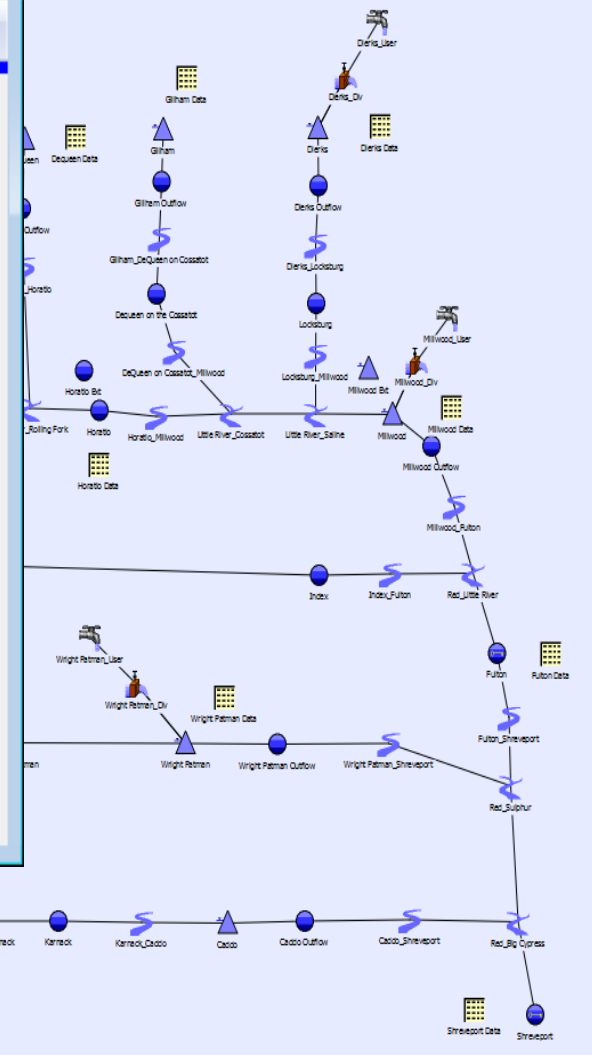
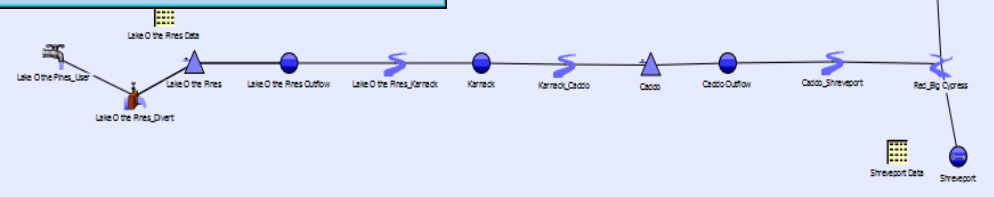
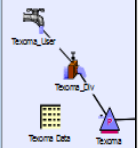
RBS Ruleset Editor - "REDCOE_6.0_BaseModel_Update_NoPi..."

File Edit Set View

Analysis\REDCOE_6.0_BaseModel_Update_NoPineRes.rls RPL Set Not Loaded

Name	Priority	On	Type
▶ P Hydropower Releases	1-1	✓	Policy Group
▶ P Compute Reservoir Diversion	2-2	✓	Policy Group
▶ P Meet Low Flow Requirements	3-15	✓	Policy Group
▶ P Flood Control	16-16	✓	Policy Group
▶ P Regulation Discharge	17-17	✓	Policy Group
▶ P Surcharge	18-32	✓	Policy Group
▶ P Initialize PreSimulation Timesteps	33-33	✓	Policy Group

Show: Set Description Selected Description Adv. Properties



CoE-SWD FLOOD CONTROL METHOD:

“Operating Level Balancing”

Define Balance Levels vs % Storages

Broken Bow.Operating Level Table

File Edit Row Column View Adjust

Operating Level Table

Value: 599.5 ft

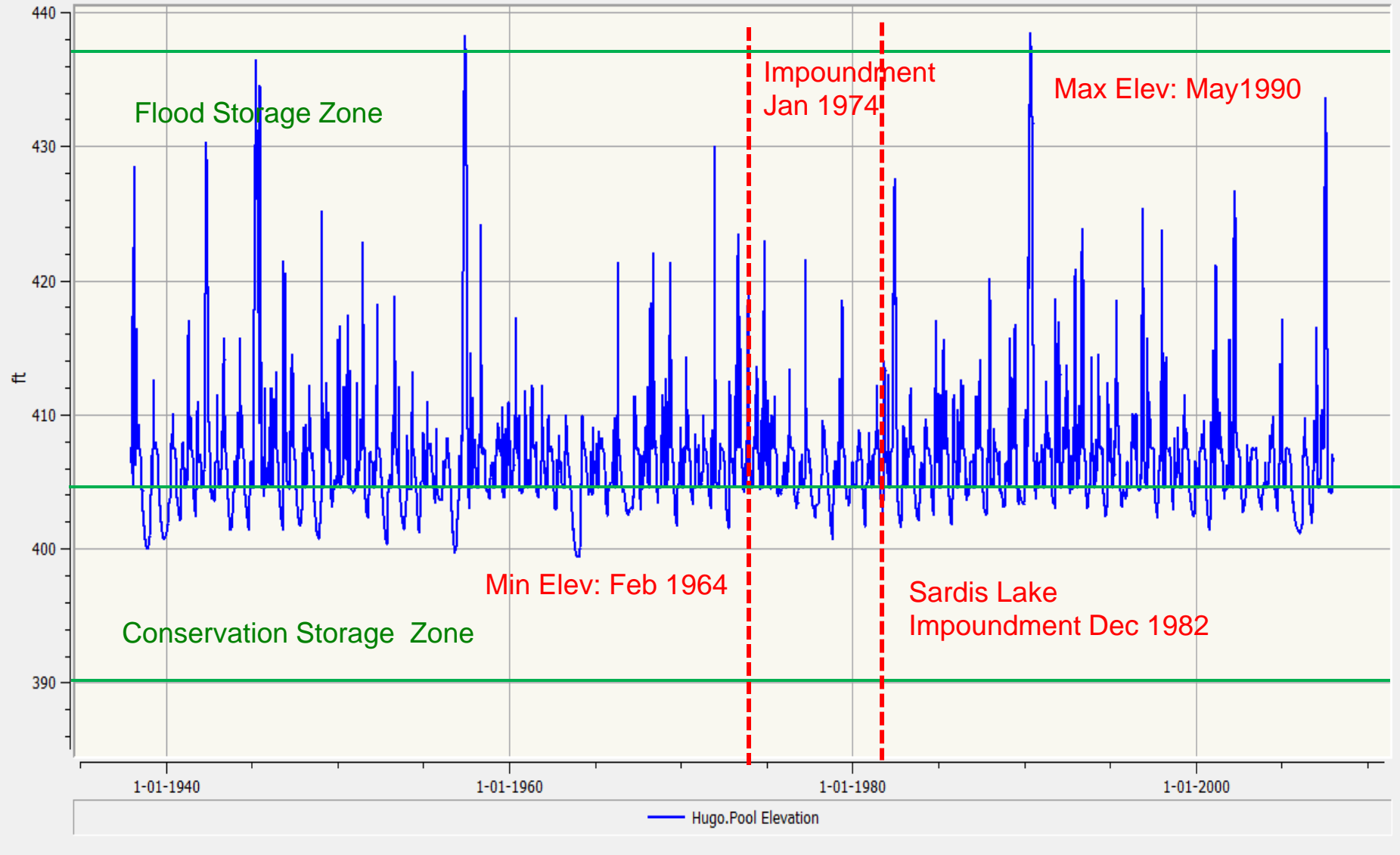
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	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE	
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	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	ft	
0:00 Apr 1	424.00	559.00	559.00	581.38	599.50	599.50	599.50	599.50	602.51	608.54	614.20	619.73	624.92	627.50	632.50	645.00		
0:00 Jun 1	424.00	559.00	559.00	583.23	602.50	602.50	602.50	602.50	605.21	610.59	615.57	620.52	625.17	627.50	632.50	645.00		
0:00 Oct 1	424.00	559.00	559.00	583.23	602.50	602.50	602.50	602.50	605.21	610.59	615.57	620.52	625.17	627.50	632.50	645.00		
0:00 Nov 1	424.00	559.00	559.00	581.38	599.50	599.50	599.50	599.50	602.51	608.54	614.20	619.74	624.92	627.50	632.50	645.00		

Show: Description

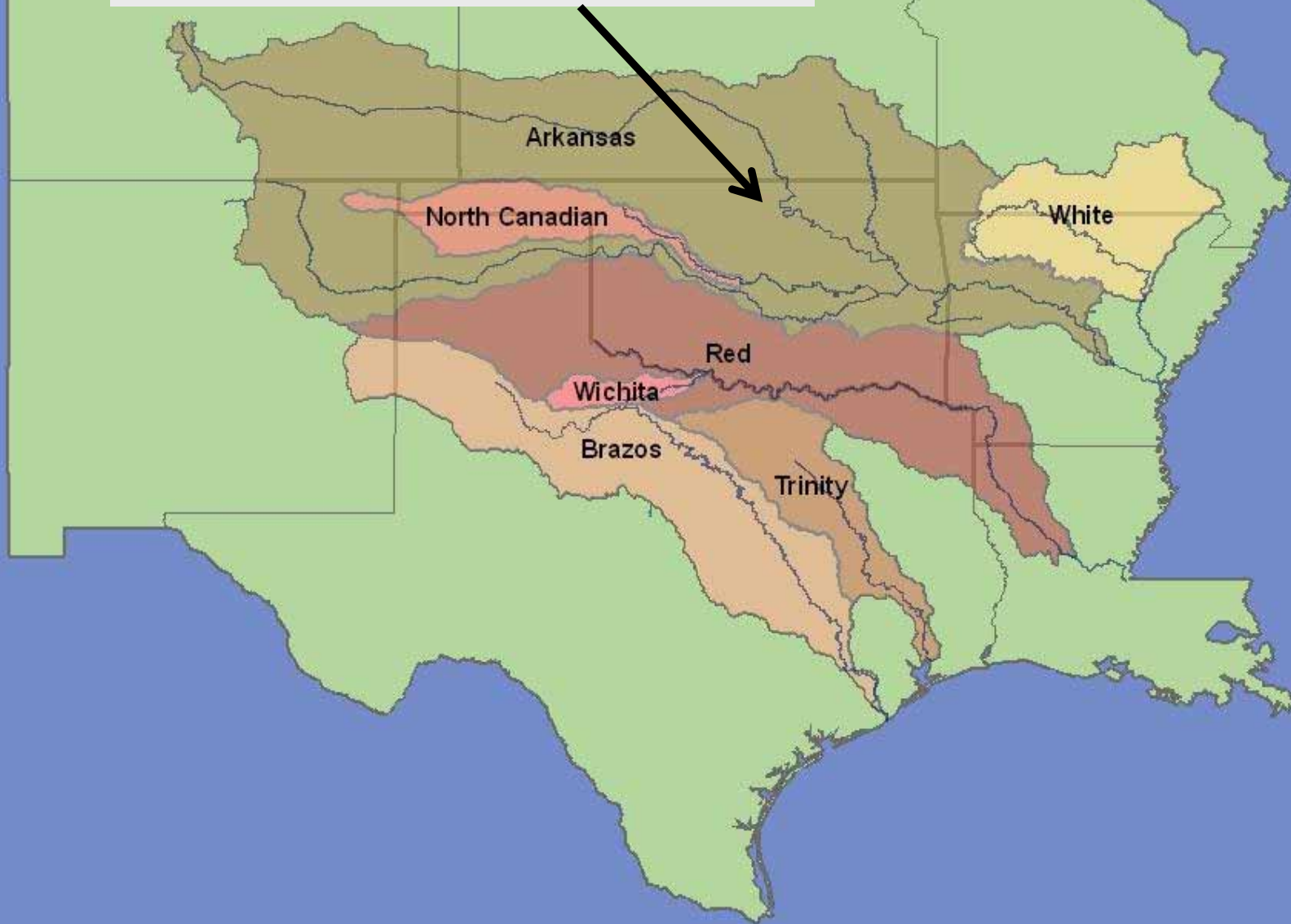
Interpolate Lookup

Annual Period, Irregular Interval

HUGO LAKE



Arkansas River Basin



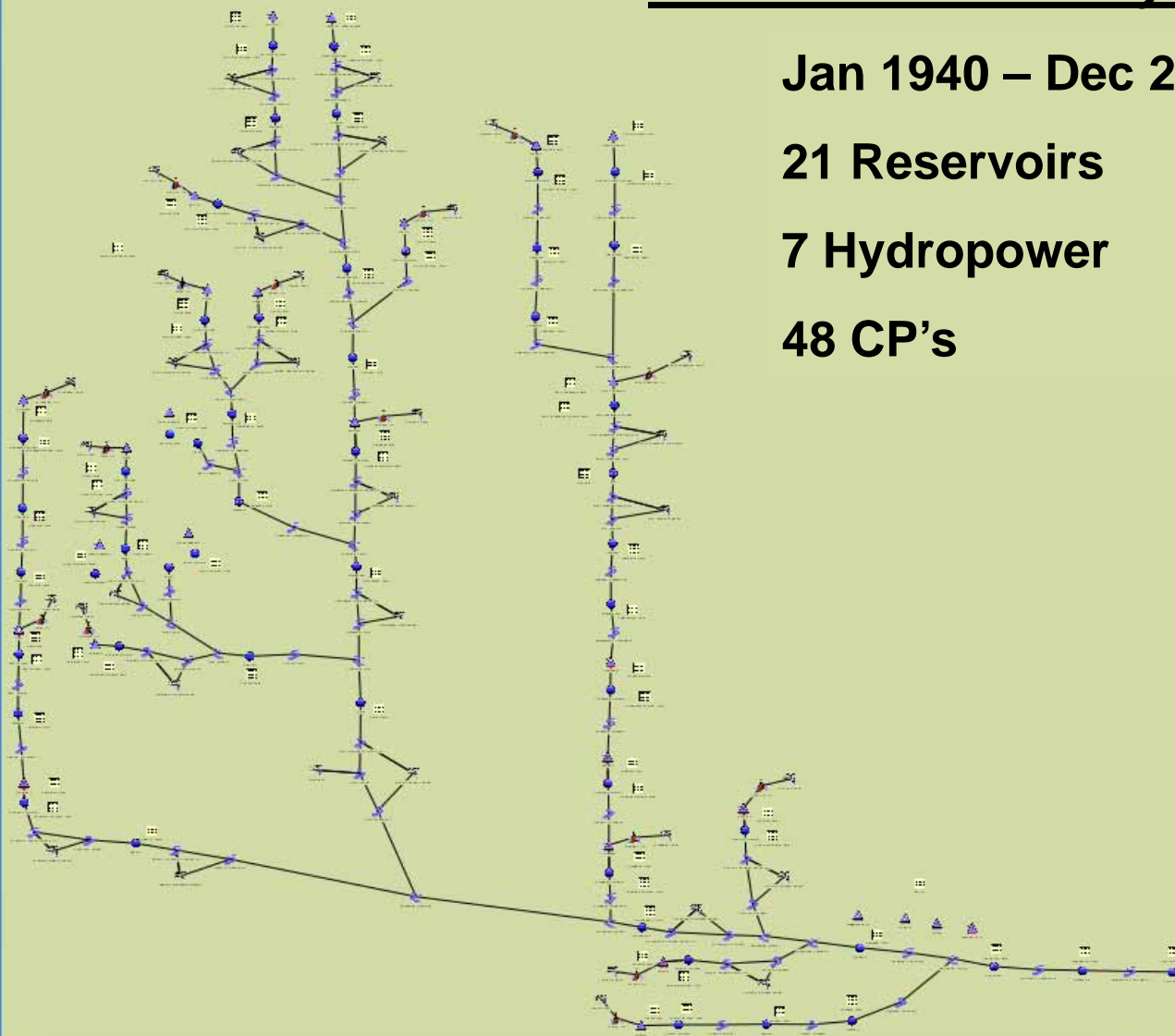
Arkansas River System

Jan 1940 – Dec 2008

21 Reservoirs

7 Hydropower

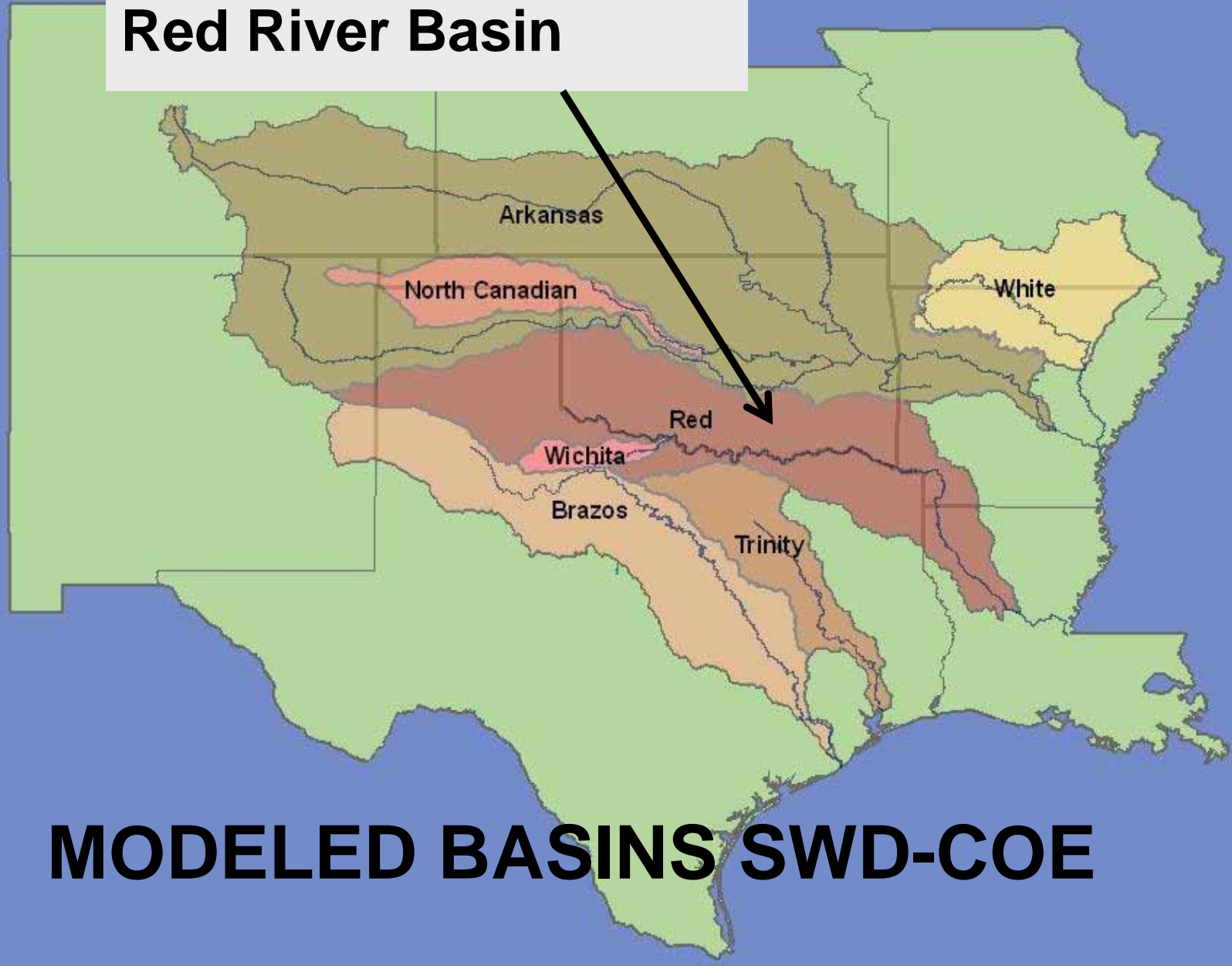
48 CP's



Simulation Object List

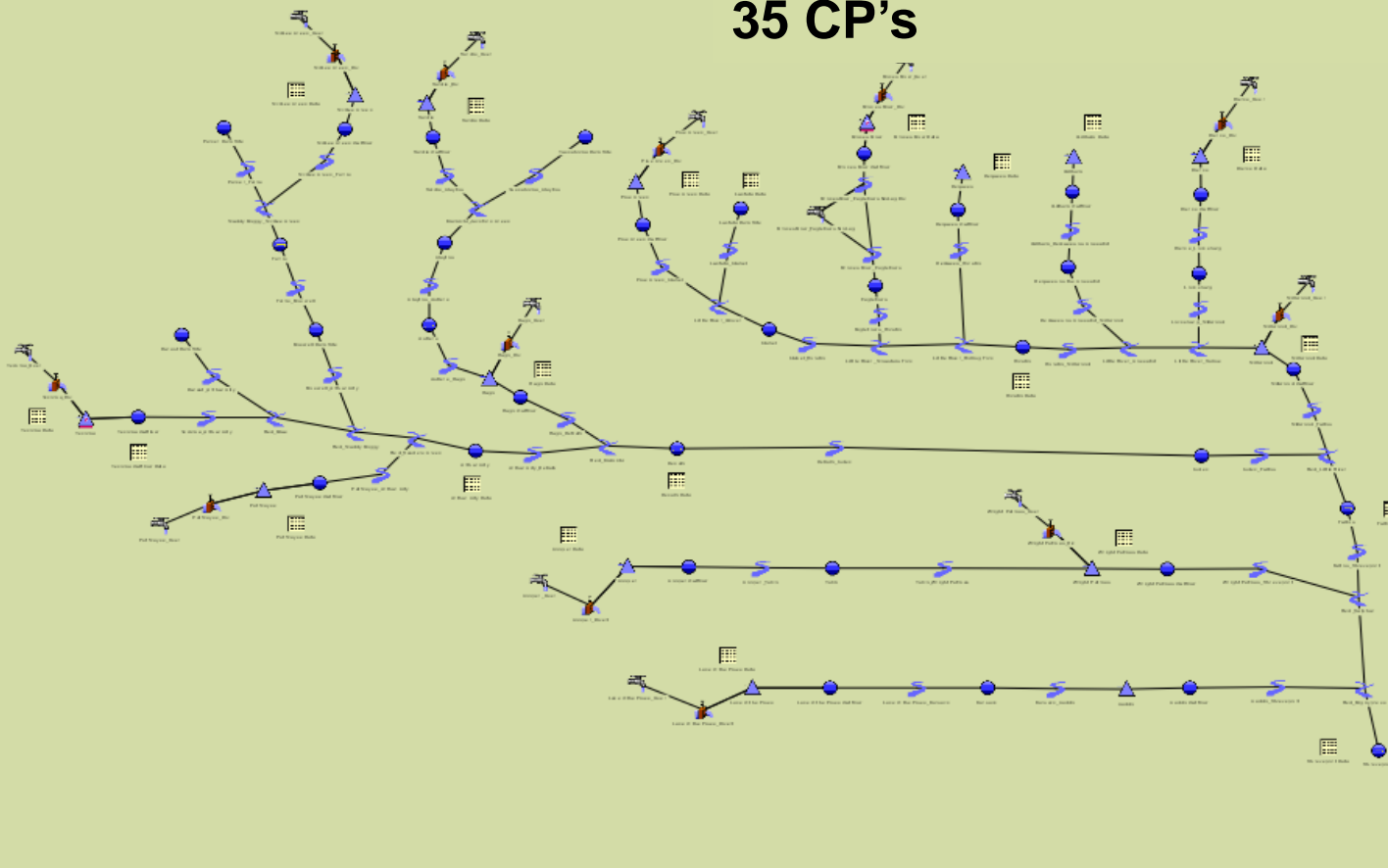
- Sort by Name
- Poteau_Data
 - Poteau_Panama
 - Ralston
 - Ralston_Data
 - Ralston_Keystone
 - Ramona
 - Ramona_Claremore
 - Ramona_Data
 - RS Kerr
 - Sallisaw
 - Sallisaw_Data
 - Sallisaw_Van Buren
 - Sand
 - Sand Damsite
 - Sand Outflow
 - Sand Outflow_Data
 - Sand_Ramona
 - Skiatook
 - Skiatook Data
 - Skiatook Outflow
 - Skiatook Outflow_Data
 - Skiatook_Div
 - Skiatook_Sperry
 - Skiatook_Sperry NoLag
 - Skiatook_Sperry NoLag I
 - Skiatook_User
 - Sperry
 - Sperry_Data
 - Sperry_Inola
 - Tenkiller
 - Tenkiller Data
 - Tenkiller Outflow_Data
 - Tenkiller_Div
 - Tenkiller_Outflow
 - Tenkiller_Sallisaw
 - Tenkiller_Sallisaw NoLag
 - Tenkiller_Sallisaw NoLag I
 - Tenkiller_User
 - Toronto
 - Toronto Data

Red River Basin



MODELED BASINS SWD-COE

Red River System: Jan 1937 – Dec 2007
15 Reservoirs
2 Hydropower
35 CP's



- Simulation Object List
- Sort by Name
- Objects
- Antlers
 - Antlers_Hugo
 - Arthur City
 - Arthur City Data
 - Arthur City_DeKalb
 - Boken Bow_User
 - Boswell Dam Site
 - Boswell_Arthur City
 - Broken Bow
 - Broken Bow Data
 - Broken Bow Outflow
 - Broken Bow_Div
 - Broken Bow_Eagletown
 - BrokenBow_Eagletown M
 - BrokenBow_Eagletown M
 - Caddo
 - Caddo Outflow
 - Caddo_Shreveport
 - Clayton
 - Clayton_Antlers
 - Cooper
 - Cooper Data
 - Cooper Outflow
 - Cooper_Divert
 - Cooper_Talco
 - Cooper_User
 - DeKalb
 - DeKalb Data
 - DeKalb_Index
 - DeQueen
 - DeQueen Data
 - DeQueen on Cossatot_M
 - DeQueen on the Cossatot
 - DeQueen Outflow
 - DeQueen_Horatio
 - Dierks
 - Dierks Data
 - Dierks Outflow
 - Dierks_Div
 - Dierks_Locksburg

RECENT & ONGOING STUDIES WITH **RIVERWARE:**

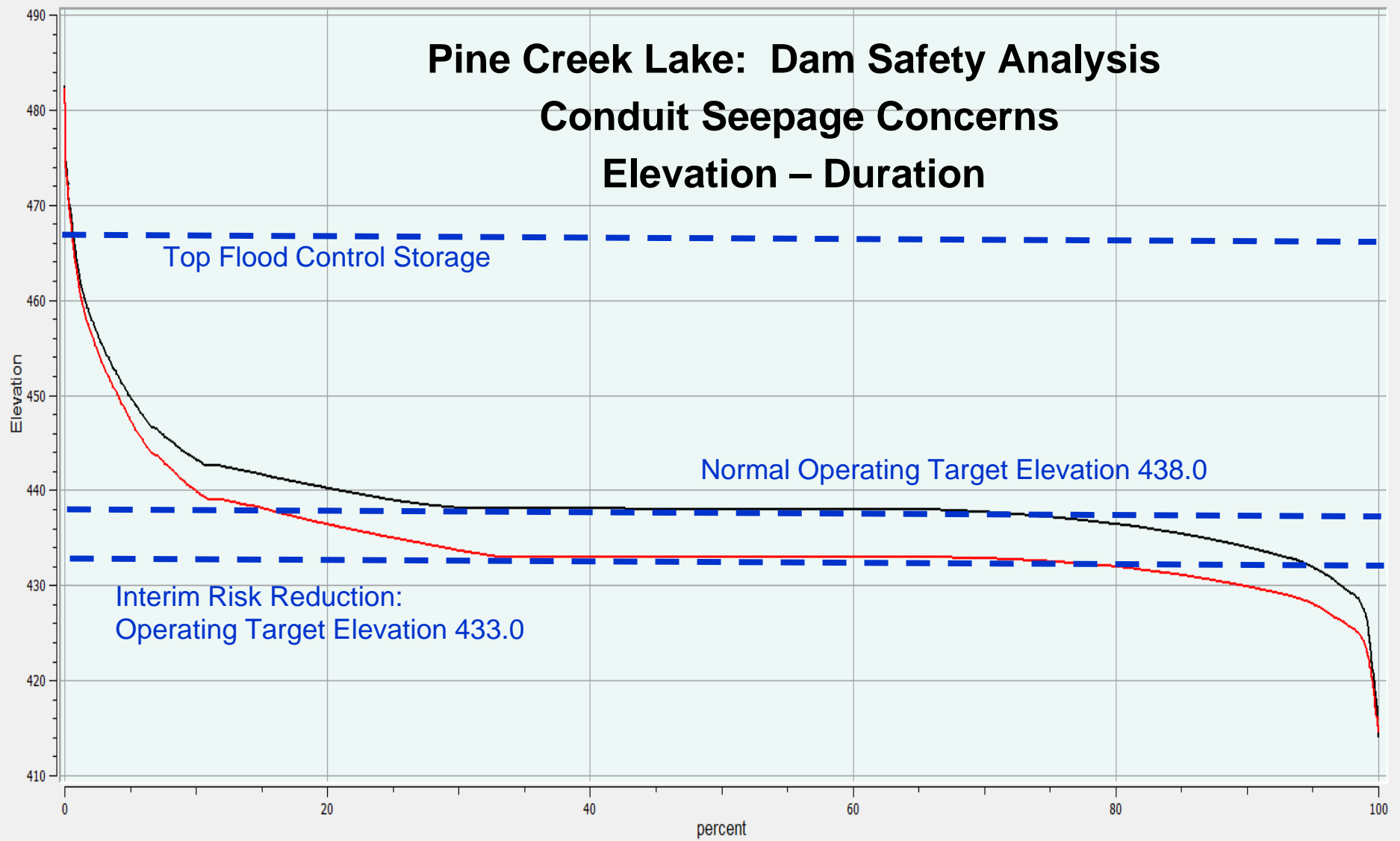
- **Dam & Levee Safety Analyses**
- **Reservoir Control Manual Updates**
- **Capacity Resurveys**
- **Instream Sustainability**
- **Alternative Seasonal Pool Operation**
- **Lower Basin Diversion Analysis**



Pine Creek Lake: Dam Safety Analysis

Conduit Seepage Concerns

Elevation – Duration



— Pine Creek Data.Elevation Duration 438 (Percent of time equaled or exceeded x Pool Elevation) — Pine Creek Data.Elevation Duration 433(Percent of time equaled or exceeded x Pool Elevation)

**TORONTO LAKE
VERDIGRIS RIVER, KANSAS
WATER CONTROL MANUAL**

**APPENDIX C – PART I
TO
WATER CONTROL MASTER MANUAL
ARKANSAS RIVER BASIN**

**PREVIOUS EDITION – FEBRUARY 1990
REVISED EDITION – JUNE 2012**

**DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
OKLAHOMA**

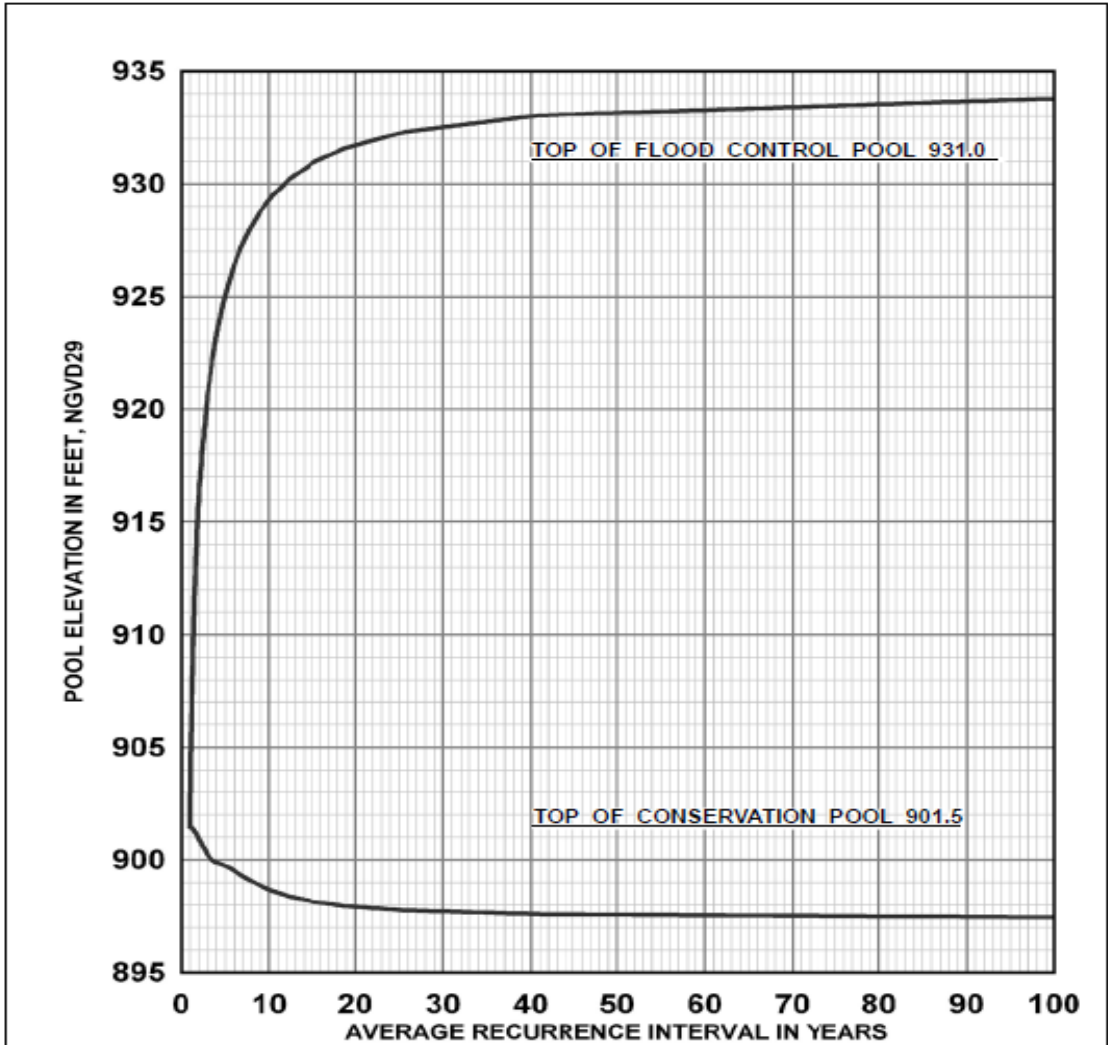


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Toronto Lake: Max & Min Annual Elevation Probability



— Toronto Data.MaxAnnualElevFreq (Max exceedence frequency in percent of years x Pool Elevation) — Toronto Data.MinAnnualElevFreq (Min exceedence frequency in percent of years x Pool Elevation)



NOTE: PERIOD OF RECORD
 JAN 1940 THRU DEC 2008
 USED "STATISTICAL
 METHODS IN HYDROLOGY"
 BY LEO BEARD FOR
 PLOTTING POSITION

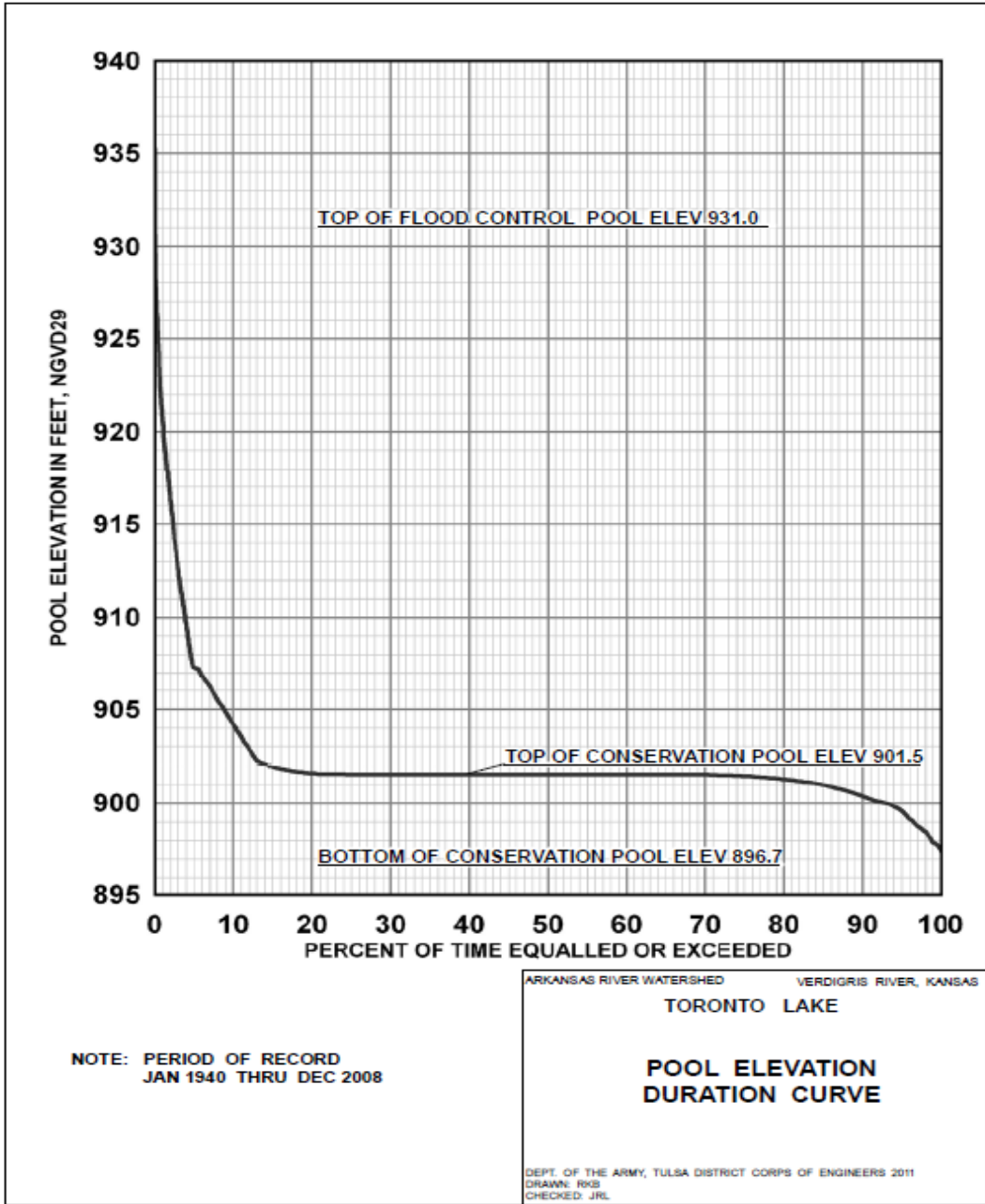
ARKANSAS RIVER WATERSHED VERDIGRIS RIVER, KANSAS
 TORONTO LAKE

**POOL ELEVATION
 PROBABILITY CURVE**

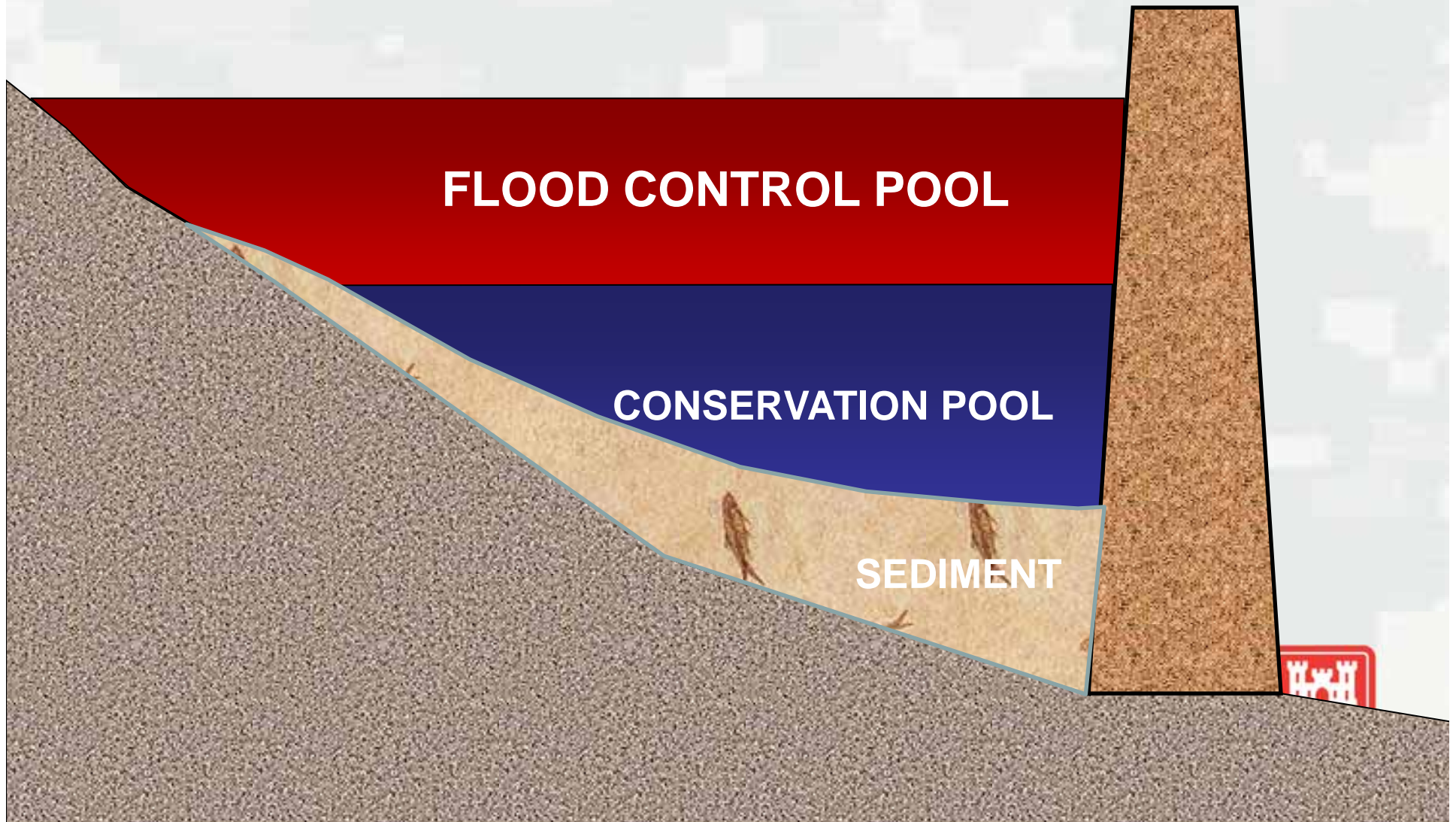
DEPT. OF THE ARMY, TULSA DISTRICT CORPS OF ENGINEERS 2011
 DRAWN: RKB
 CHECKED: JRL

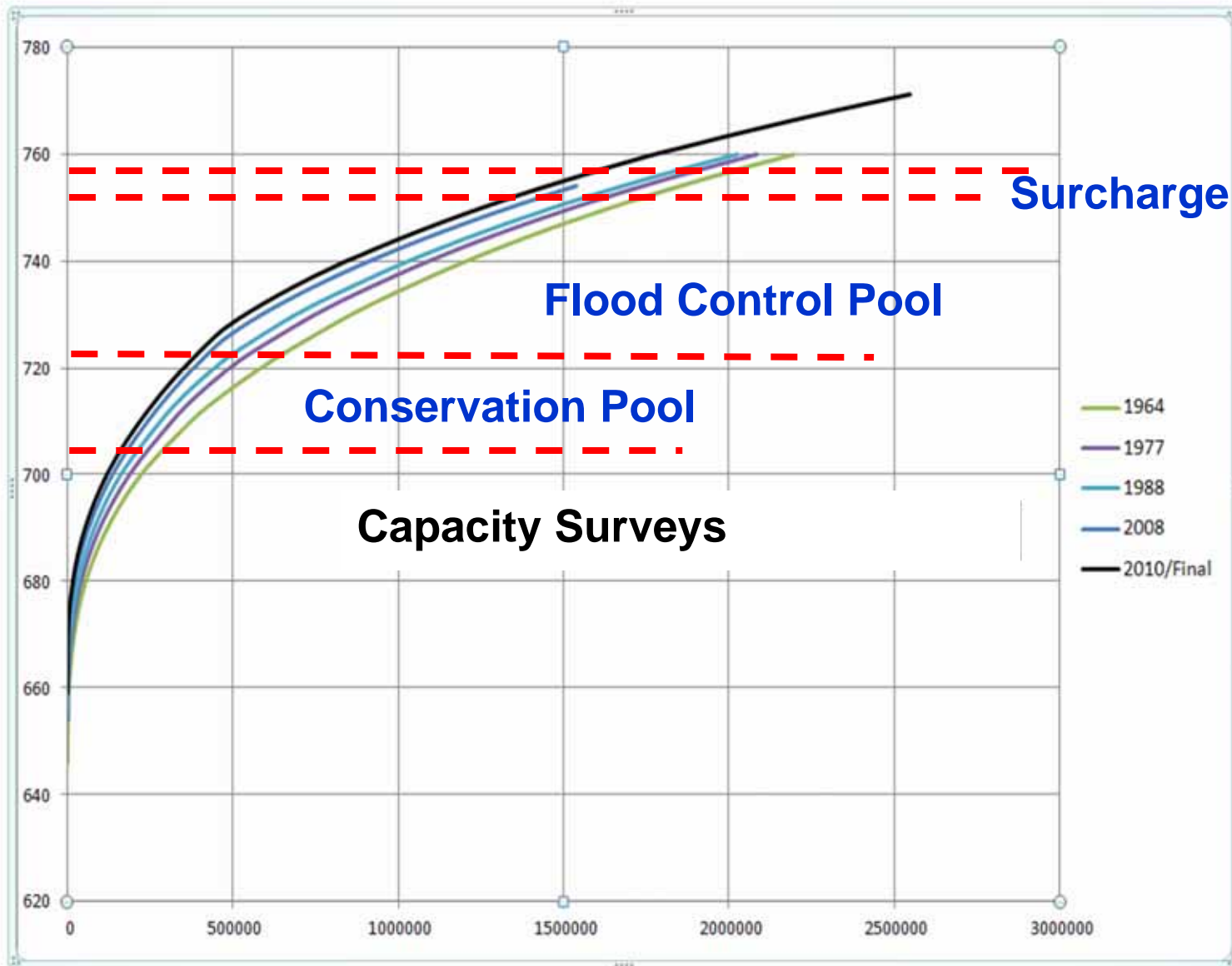
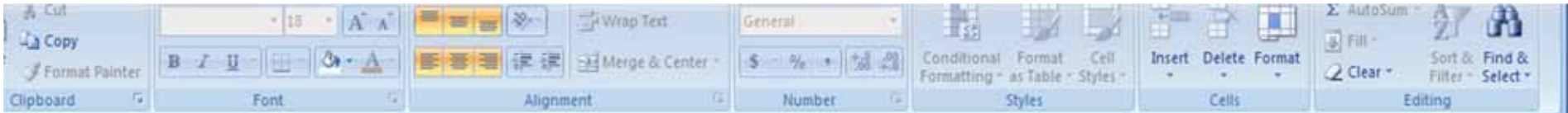


.DING STRONG®



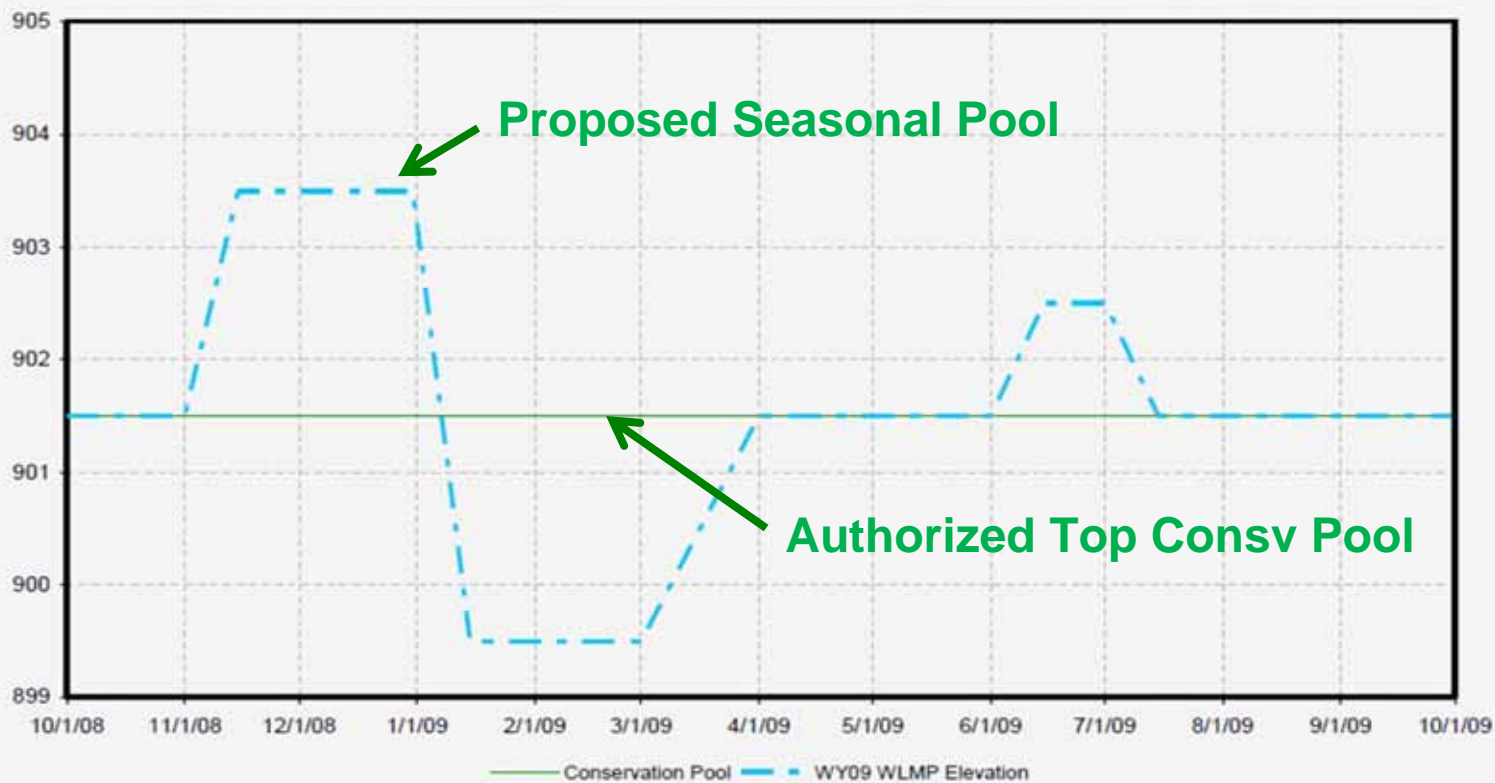
Volume Lost to Sediment





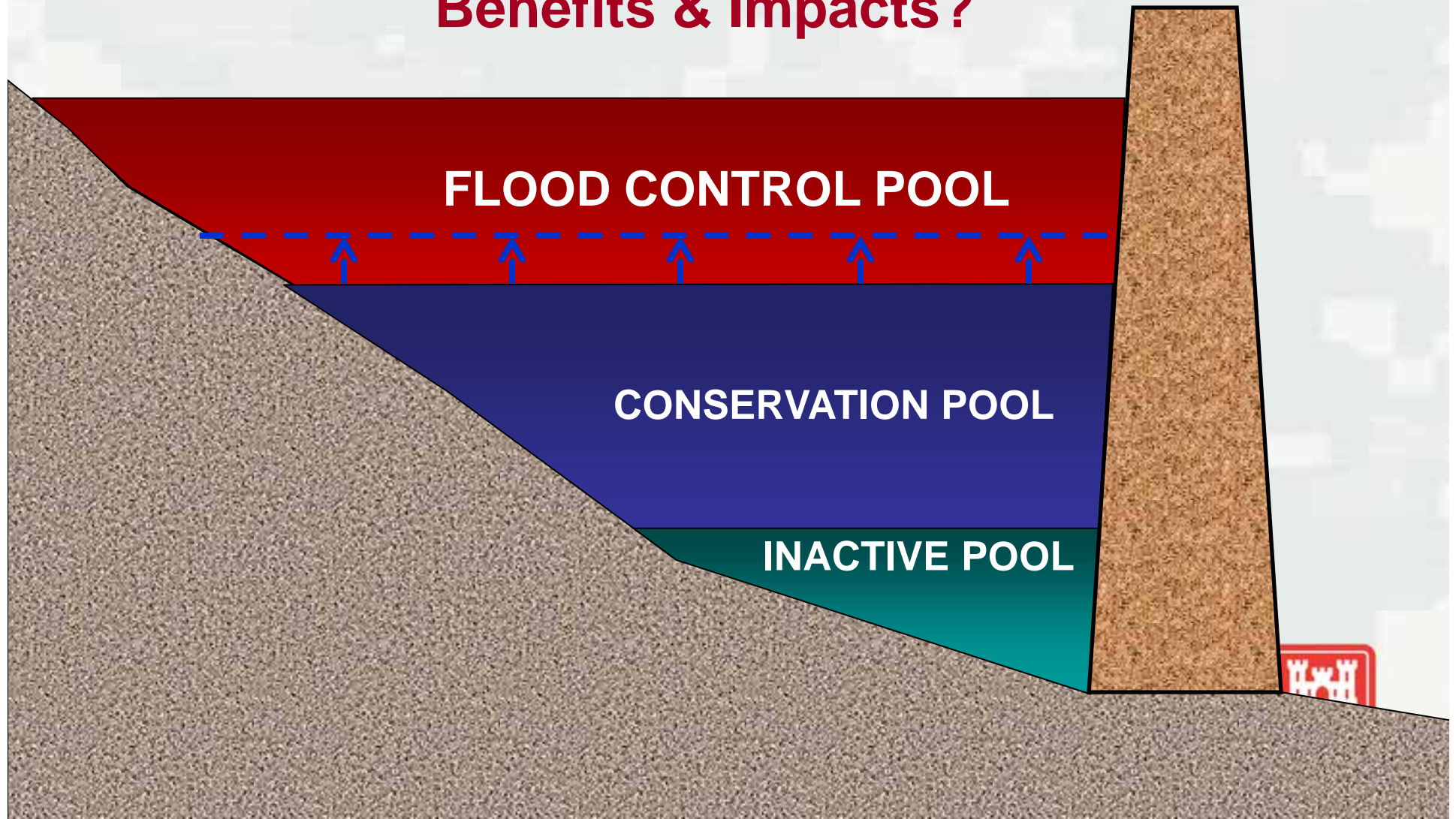
Toronto Reservoir

Conservation Pool = 901.5 Flood Pool = 931.0 5% into FP = 904.5



Reallocate Portion of Flood Control Storage to Additional Conservation Storage....

Benefits & Impacts?



Need for RiverWare Program:

- **Reservoir & System Analyses**
- **Existing Regulation Criteria**
- **Proposed Alternative Scenarios**
- **Evaluate Results**



THANK YOU!



05/11/2011 09:35