Water Injection Dredging (WID) Project Tuttle Creek Lake

July 11, 2018

Kansas Water Office

Outline

- Reservoir Sedimentation
- Water Supply Projections
- Tuttle Creek Lake – Past, Present & Future
- Hydrosuction & **Water Injection Dredging**
- ERDC Study
- PAS Agreements – Corps & State of Kansas
- Section 1122 Proposal

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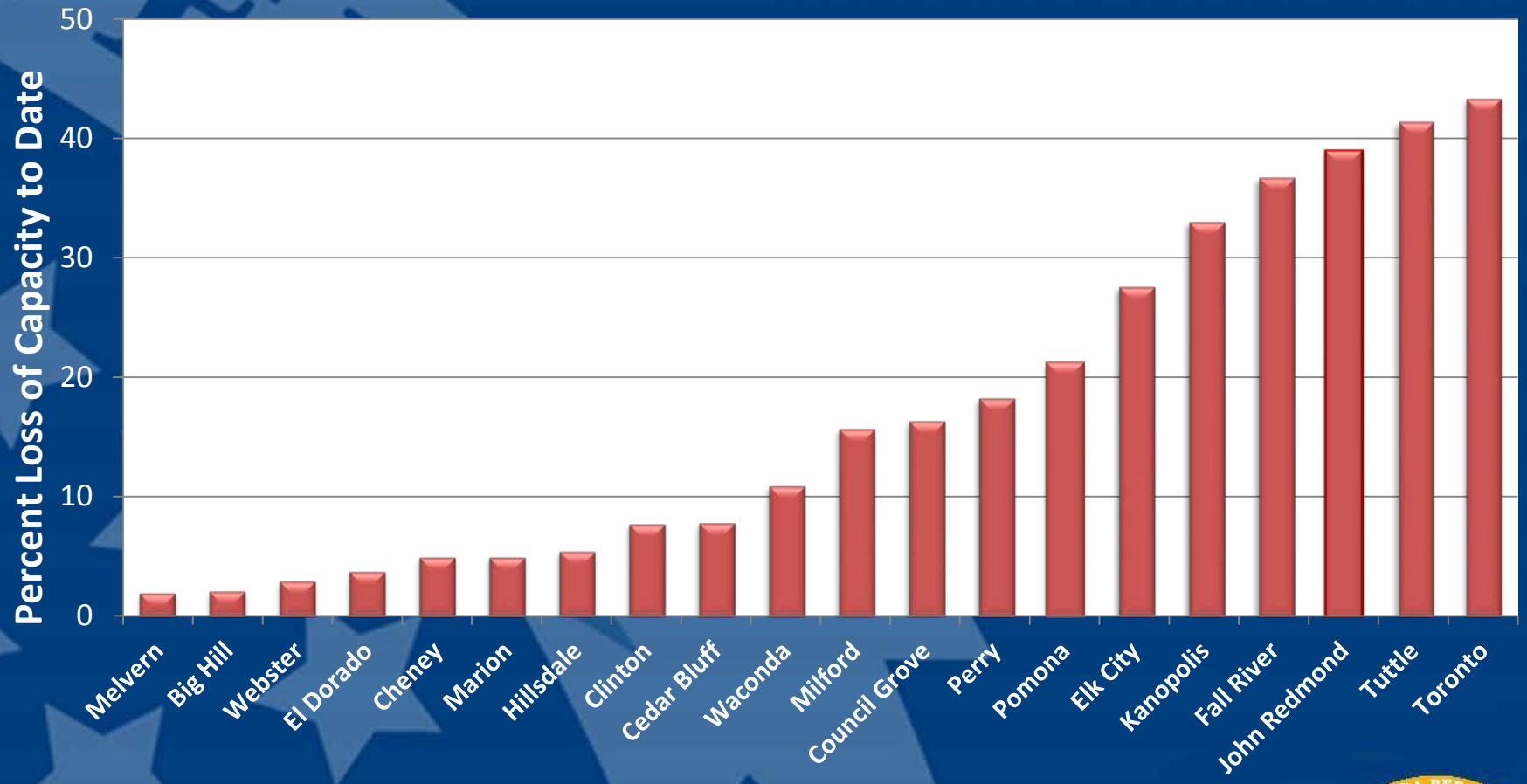
Kansas Reservoir Loss of Capacity



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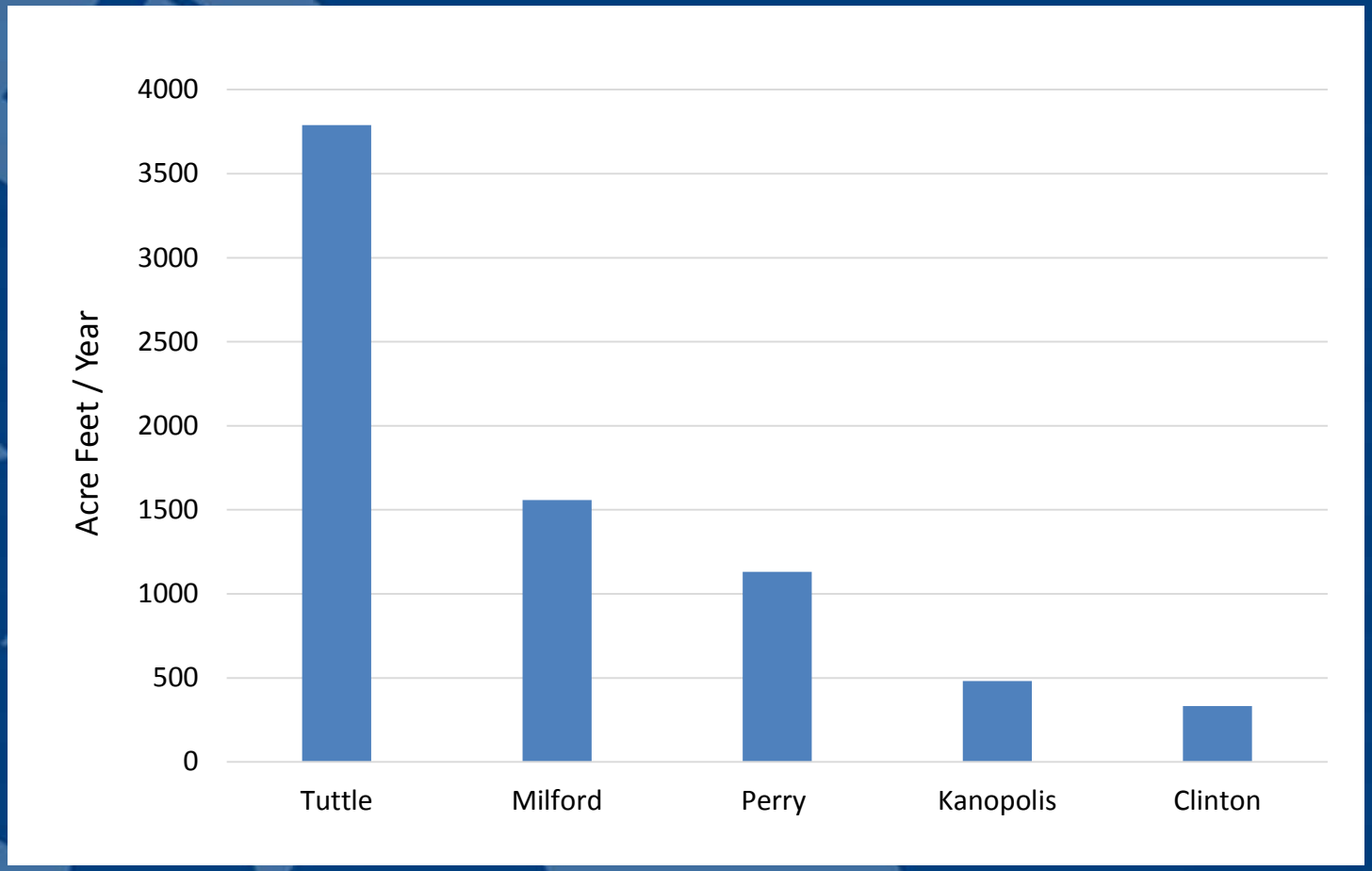
Sediment Accumulation in the Kansas River Basin



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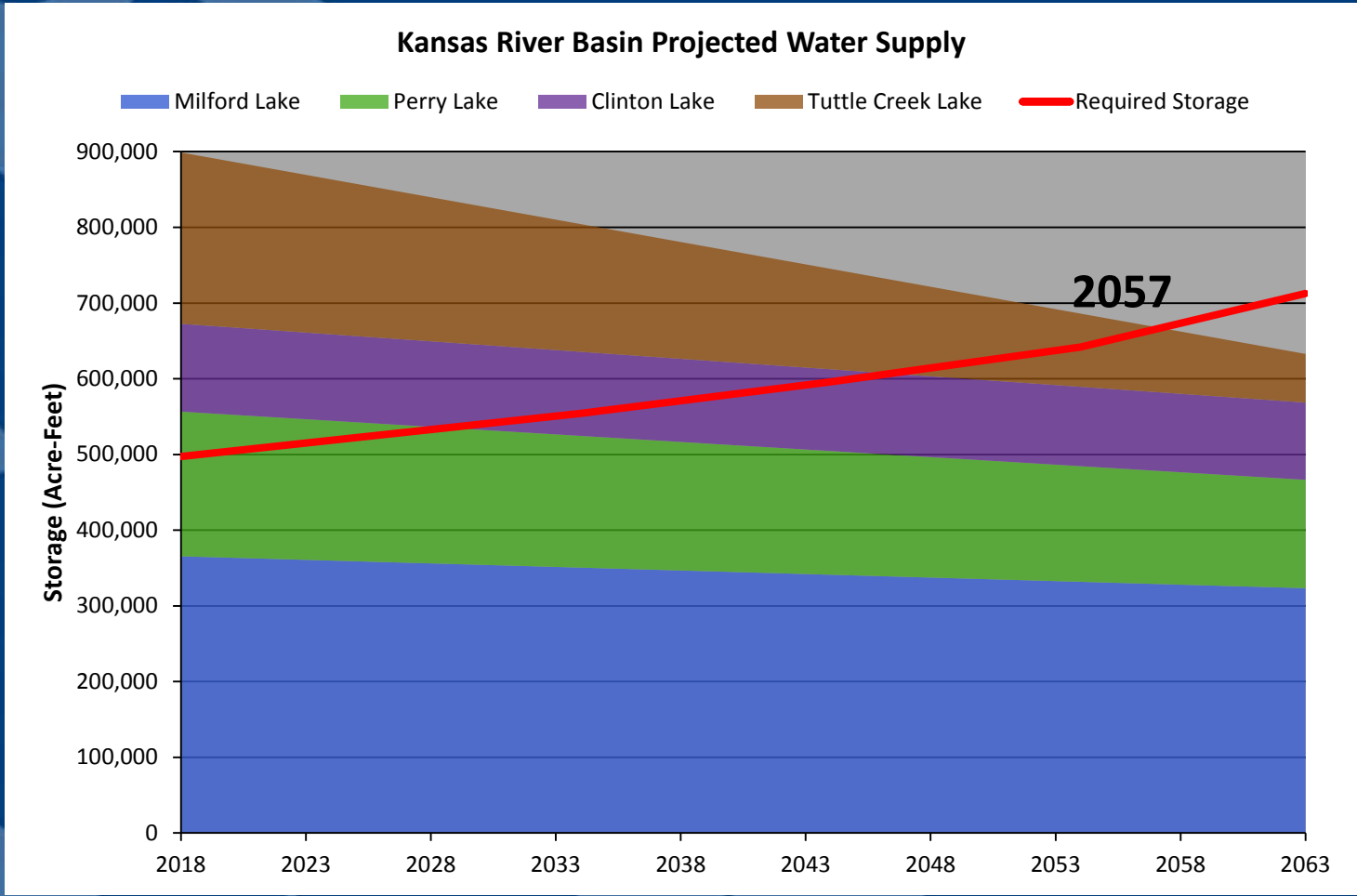
Water Supply vs. Demand



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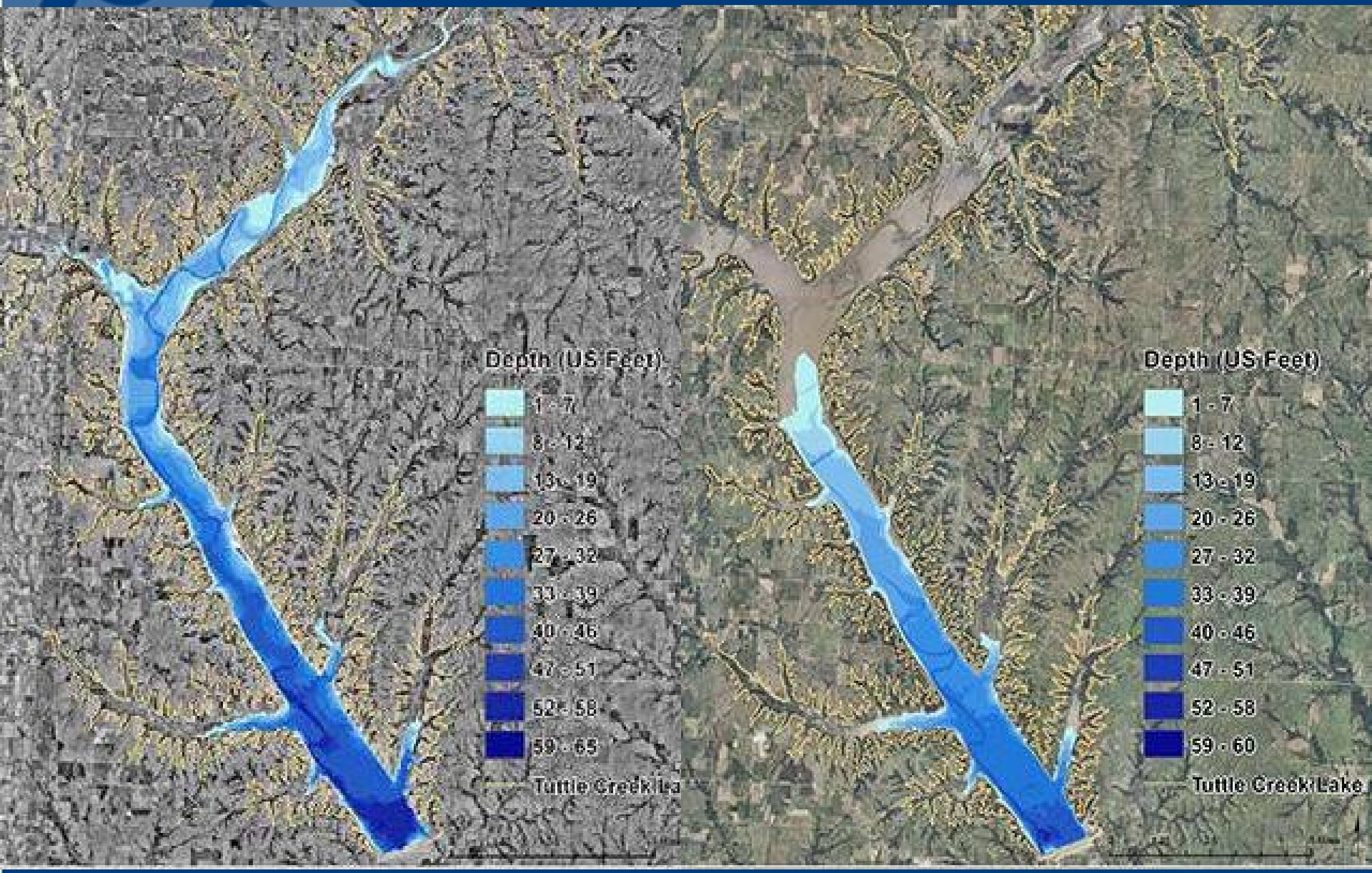
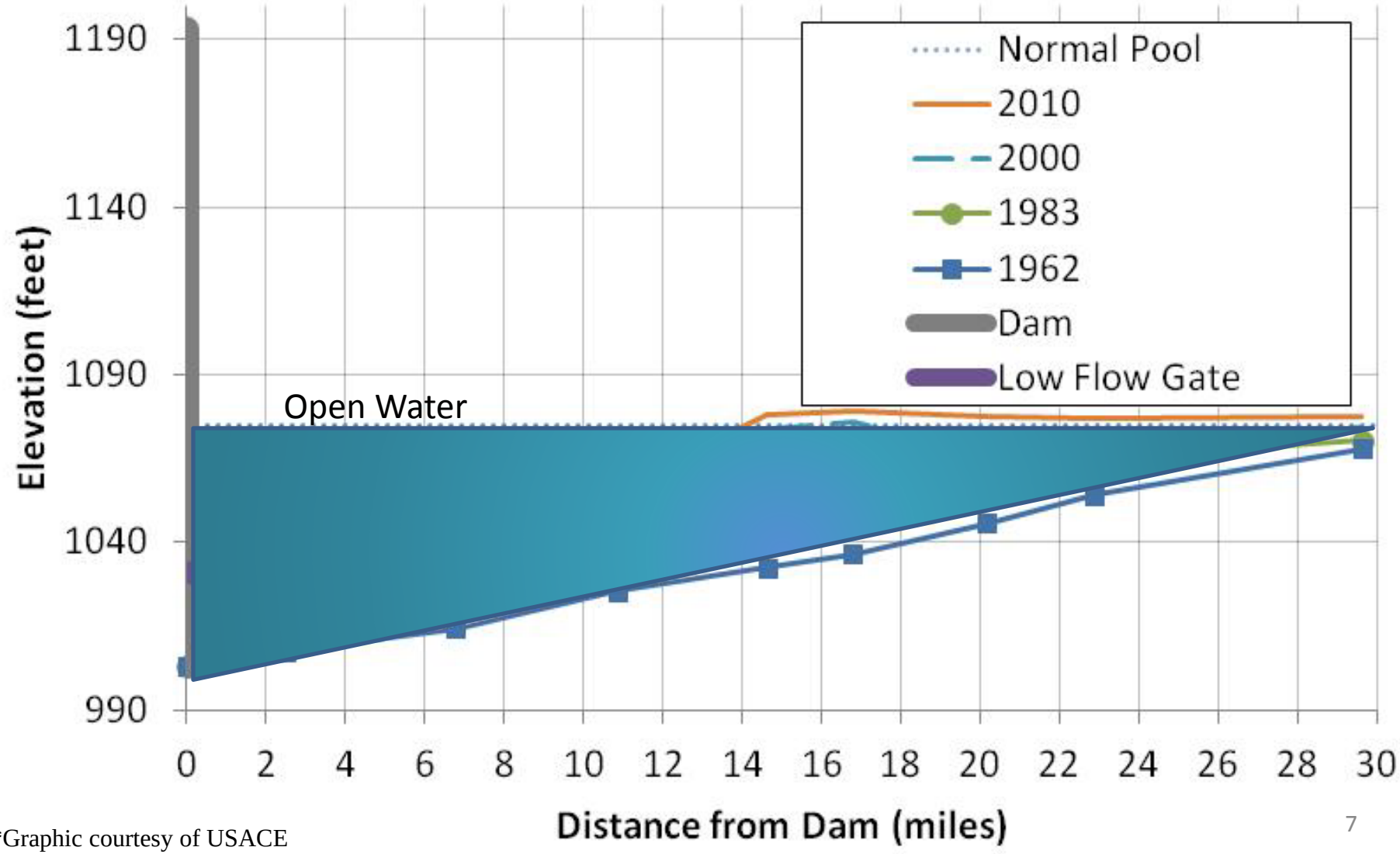
Tuttle Creek Lake: 1957 to 2010

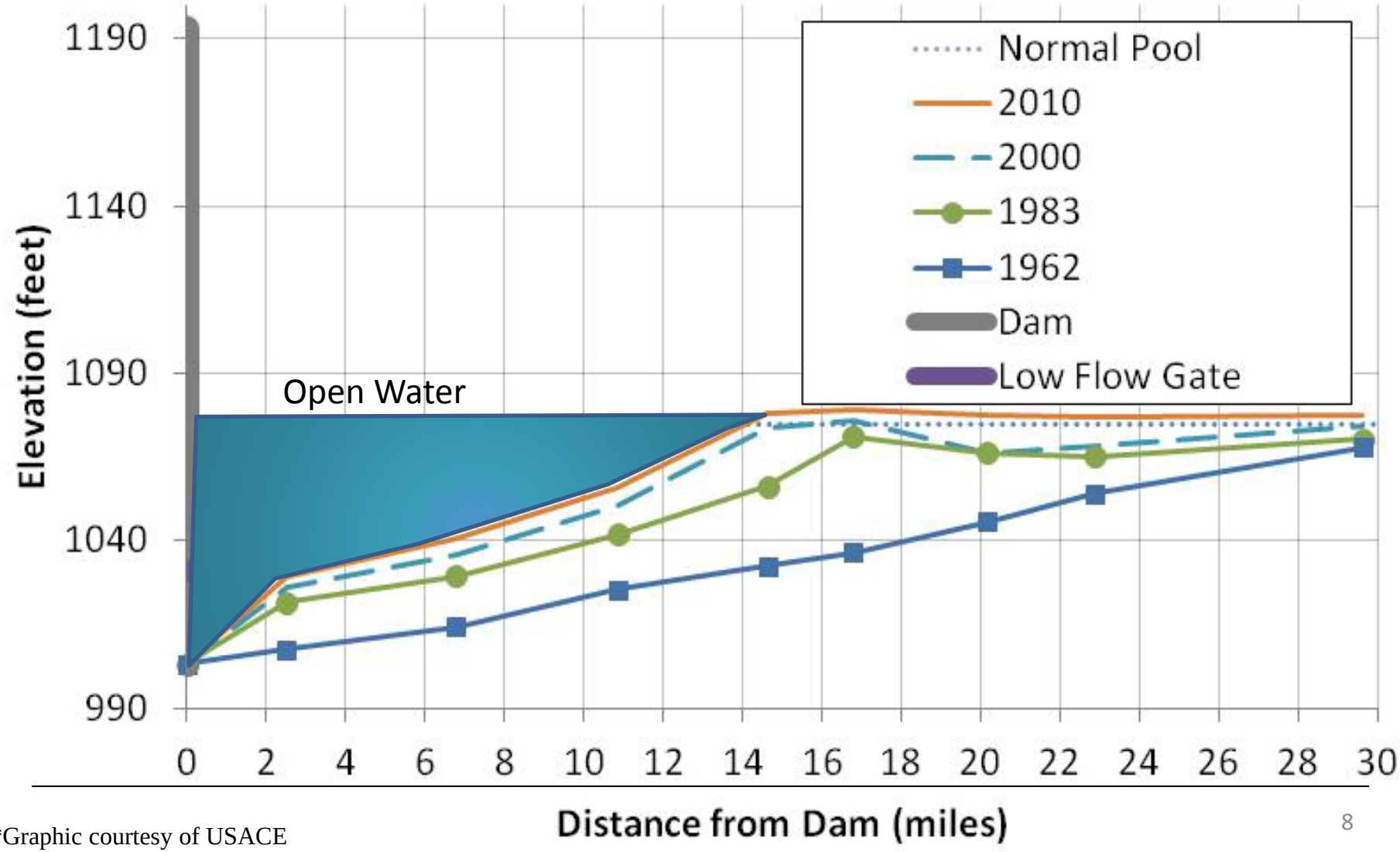


Tuttle Creek Lake: 1962



*Graphic courtesy of USACE

Tuttle Creek Lake: 2010



*Graphic courtesy of USACE

Annual Storage Volume Lost

Sedimentation rate in multi-purpose pool (1962 to 2009):

3,600 ac-ft/yr

5.6 million yd^3 / year

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Tuttle Creek Lake

At the same annual rate of sedimentation:

- **Multi-purpose pool will be 88% full in 50 years**
- **Total storage (multi-purpose + flood control) will be 21% full**

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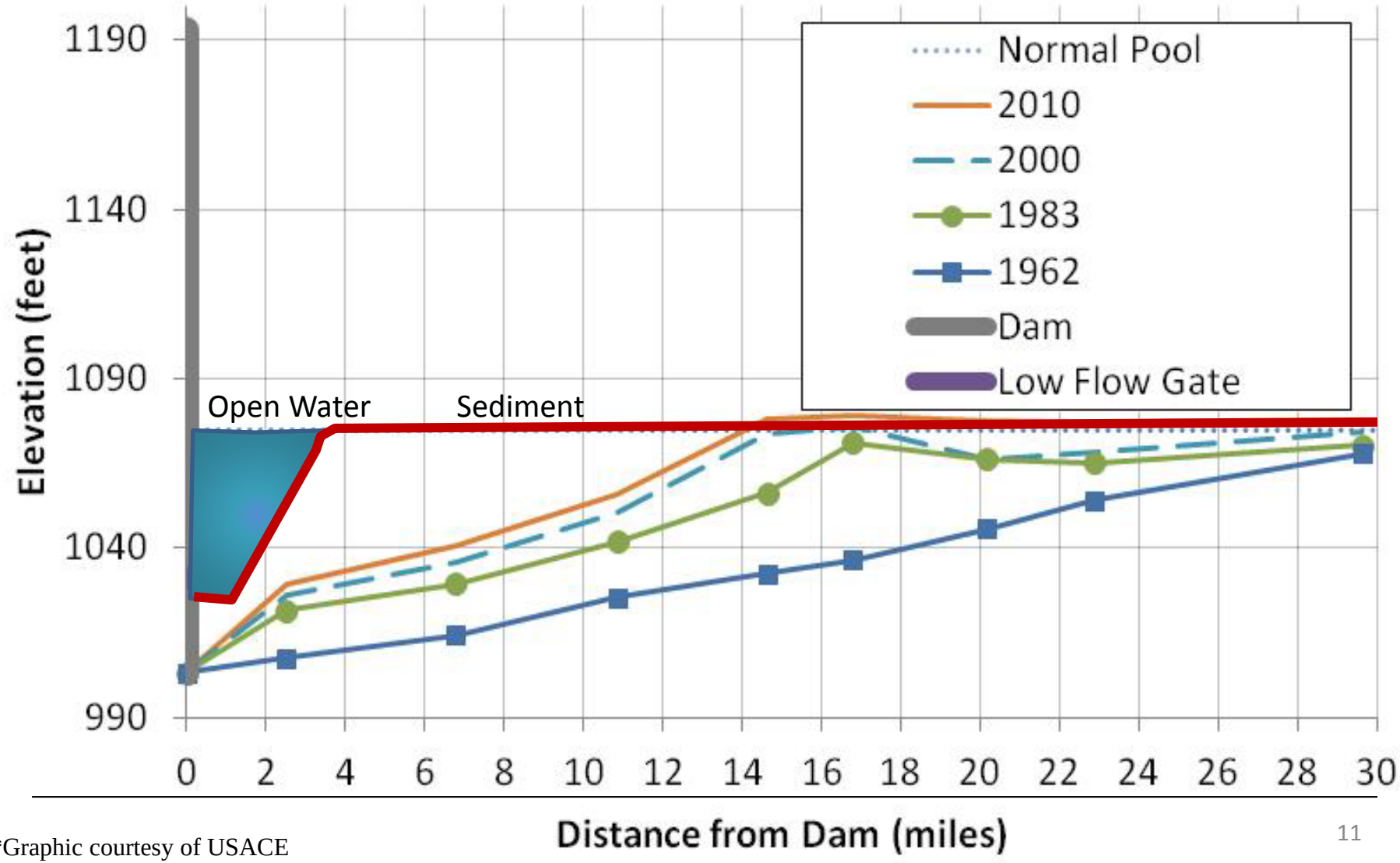
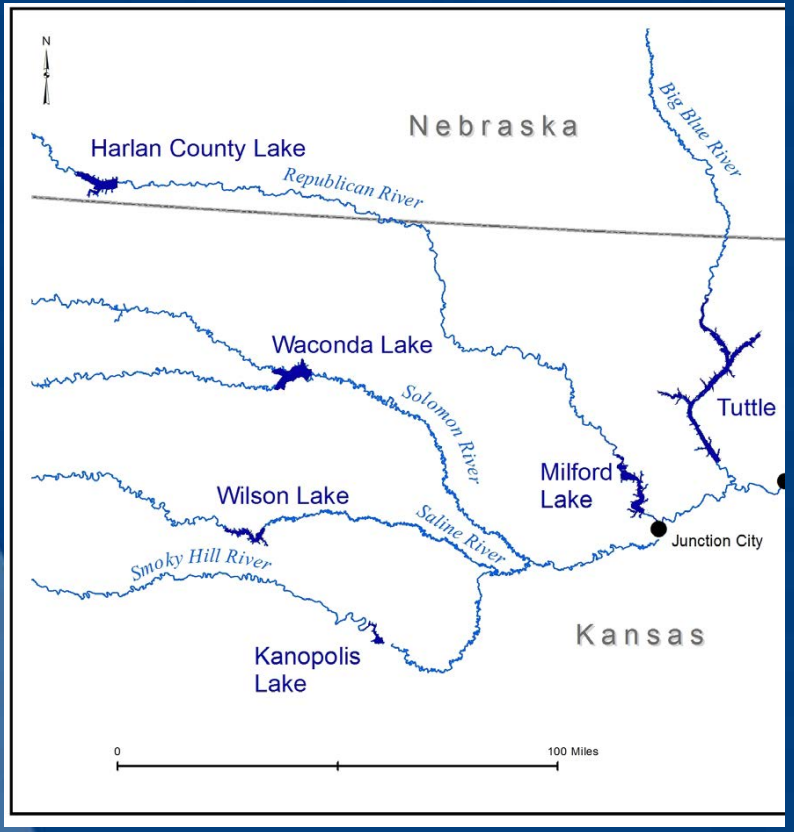
Tuttle Creek Lake: 50 years

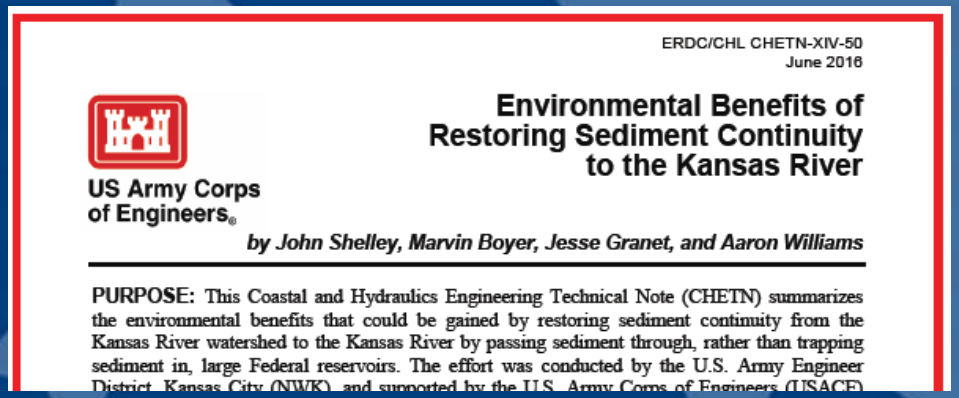


*Graphic courtesy of USACE

Environmental Impacts: Kansas River

- Pre-dam Sediment Load:
  - 44 million tons per year
- Post-dam Sediment Load:
  - 13 million tons per year
- A 70% reduction in sediment transport





ERDC/CHL CHETN-XIV-50
June 2016

US Army Corps of Engineers®

Environmental Benefits of Restoring Sediment Continuity to the Kansas River

by John Shelley, Marvin Boyer, Jesse Granet, and Aaron Williams

PURPOSE: This Coastal and Hydraulics Engineering Technical Note (CHETN) summarizes the environmental benefits that could be gained by restoring sediment continuity from the Kansas River watershed to the Kansas River by passing sediment through, rather than trapping sediment in, large Federal reservoirs. The effort was conducted by the U.S. Army Engineer District, Kansas City (NWK), and supported by the U.S. Army Corps of Engineers (USACE)

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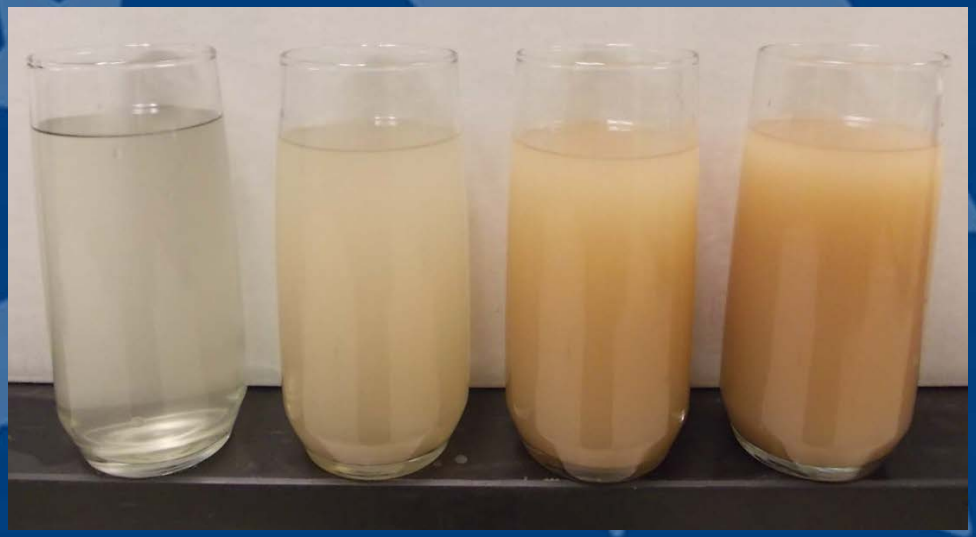
Environmental Impacts: Lack of Turbidity

- Studies by USFWS, KSU
  - Indicate certain fish species in Kansas River have substantially decreased in numbers (comparison to pre-dam conditions)
  - Some are now federally protected
  - Lack of turbidity interrupts life cycle, easier for predators



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Addressing the Problem

Watershed Efforts

- Interagency SB Team continues to implement SBS above Tuttle Creek Lake to reduce highly eroding “hotspots”
- Other best management practices

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Traditional Dredging with disposal into a CDF

- 3,600 ac-ft/year into Tuttle's multi-purpose pool
- At \$6.7/yd^3 = \$39M/year

- Cost increases as available disposal sites are filled
- Does not address the sediment deficit downstream

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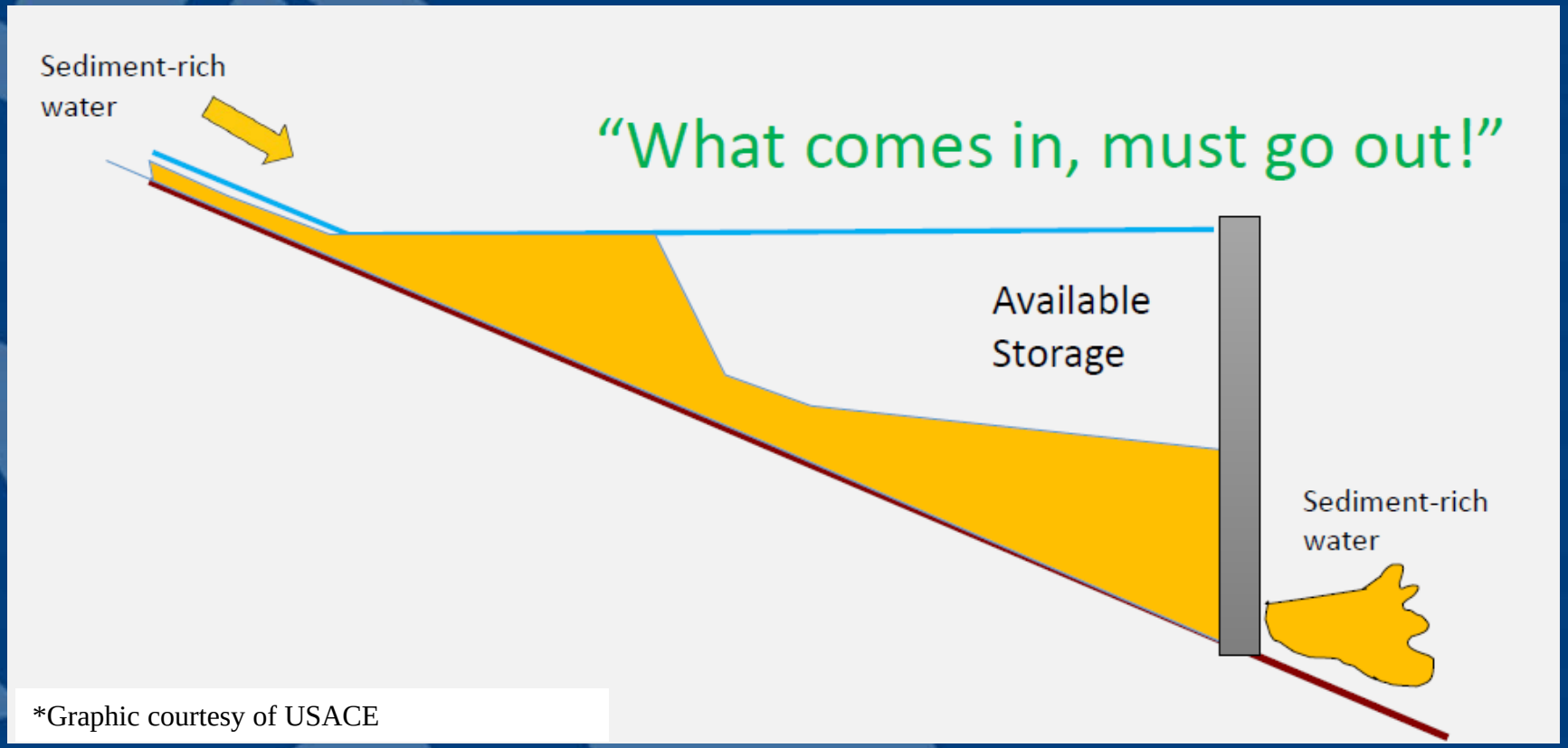
Reservoir Sediment Sustainability



*Graphic courtesy of USACE

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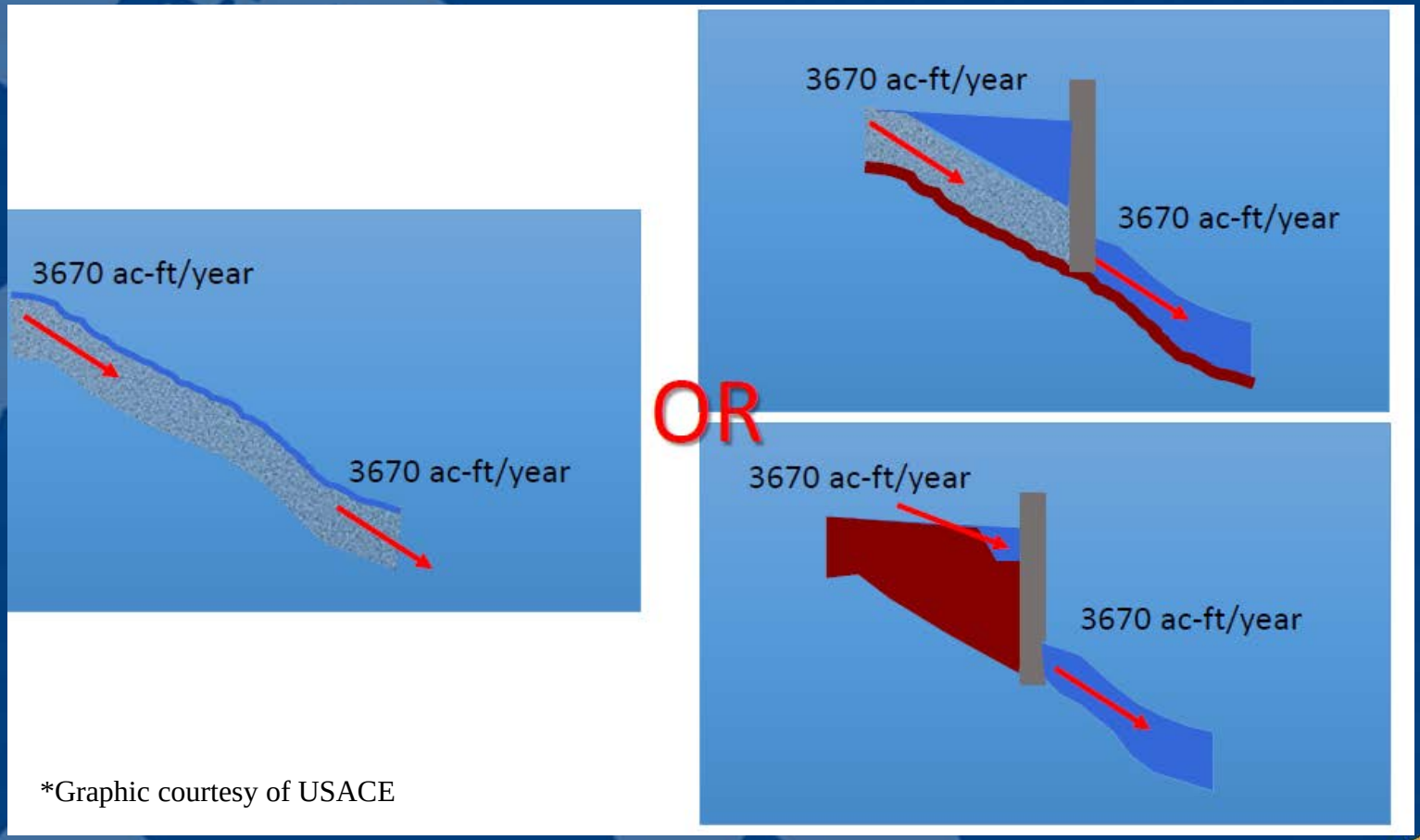
Reservoir Sustainability = Sediment Continuity NOW rather than LATER



*Graphic courtesy of USACE

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Sediment Management Strategies for Tuttle Creek Lake

Tuttle Hydrosuction

Tuttle Creek Lake Hydrosuction Assessment

September 21, 2017

Introduction

Tuttle Creek Lake is a large, multi-use USACE lake in Kansas (Figure 1) which provides significant benefits through its authorized purposes of flood control, water supply, navigation, water quality, recreation, and fish and wildlife. The multi-purpose pool of this reservoir is accumulating sediment at a rate of 5.8 million cubic yards per year. As of 2009, the reservoir had lost 40% of its multi-purpose pool storage volume. NWK and USDA performed erodibility testing of the reservoir sediment deposits in 2015 and found that the new deposits are highly erodible, but the older, more consolidated deposits are up to 200 times less erodible. In other words, it is much less expensive to maintain storage now through intentional sediment management than to attempt to restore lost storage in the future.

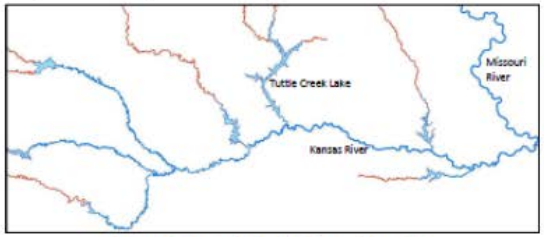
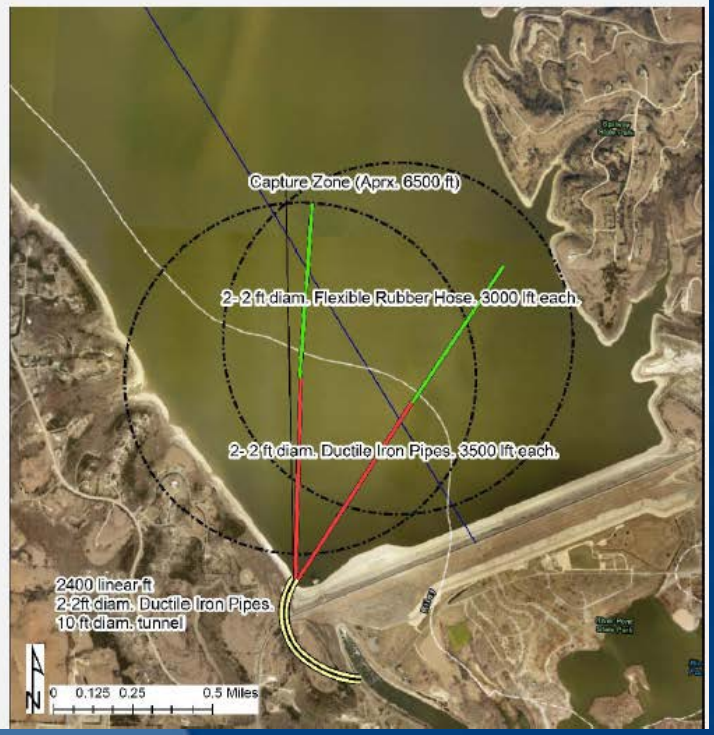


Figure 1. Tuttle Creek Lake in the Kansas River Basin

A 2013 workshop with participants from the USACE, the State of Kansas, USGS, and reservoir sedimentation experts from academia and industry identified hydrosuction as a promising option for managing sediment at Tuttle Creek Lake (Shelley 2015). A simplified analysis by McFall and Wein (2015) indicates that at multi-purpose pool level, this sediment bypass scheme could



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Tuttle Hydrosuction

- Less expensive than dredging ($6.7/yd^3)
- Would need to gradually move further from the dam for long-term operability
- Majority of capital costs are for installation of new conduit through the abutment without draining the lake
- White paper (Shelley) recommended study of five alternatives, including **water injection dredging**

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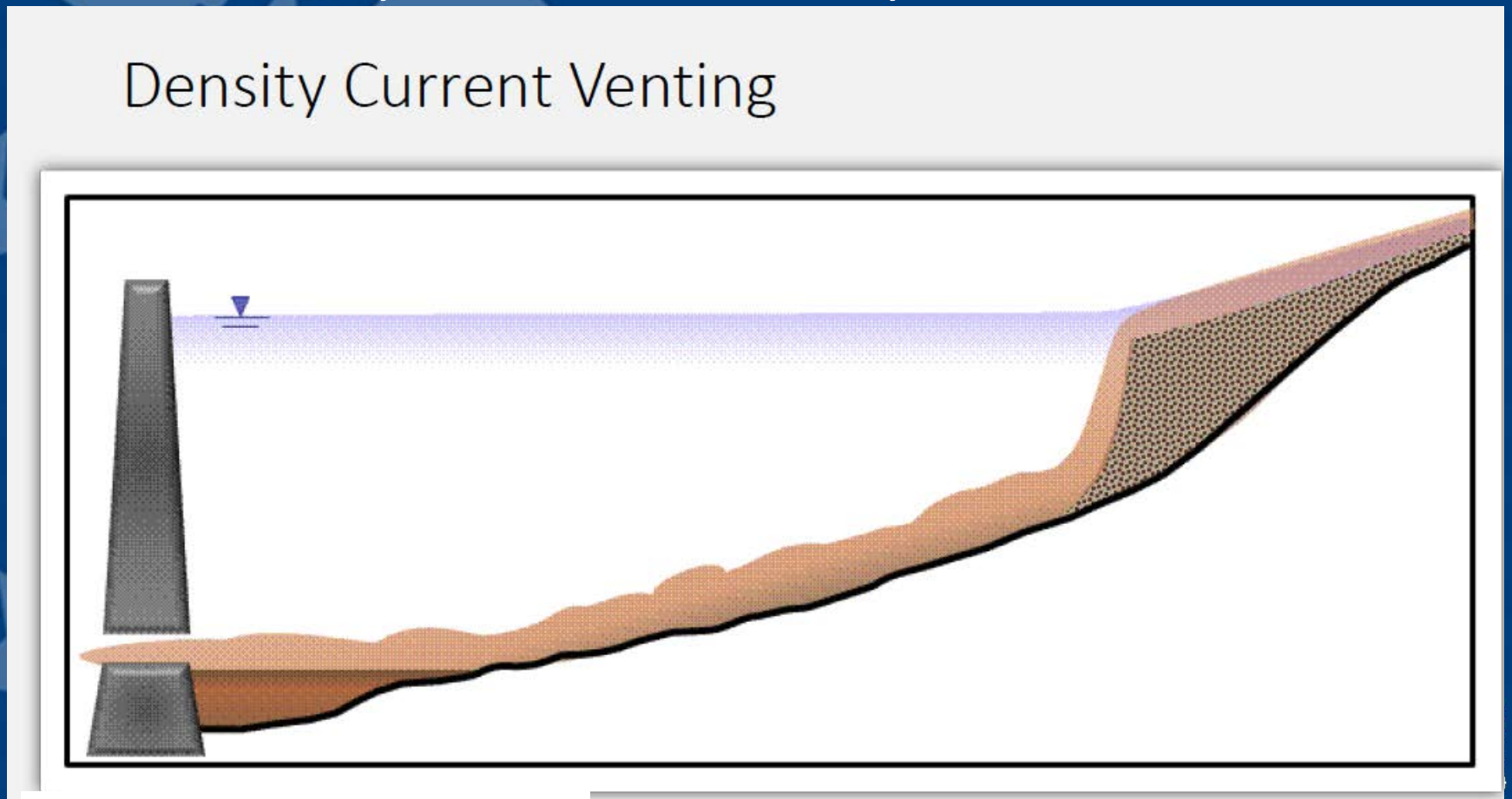
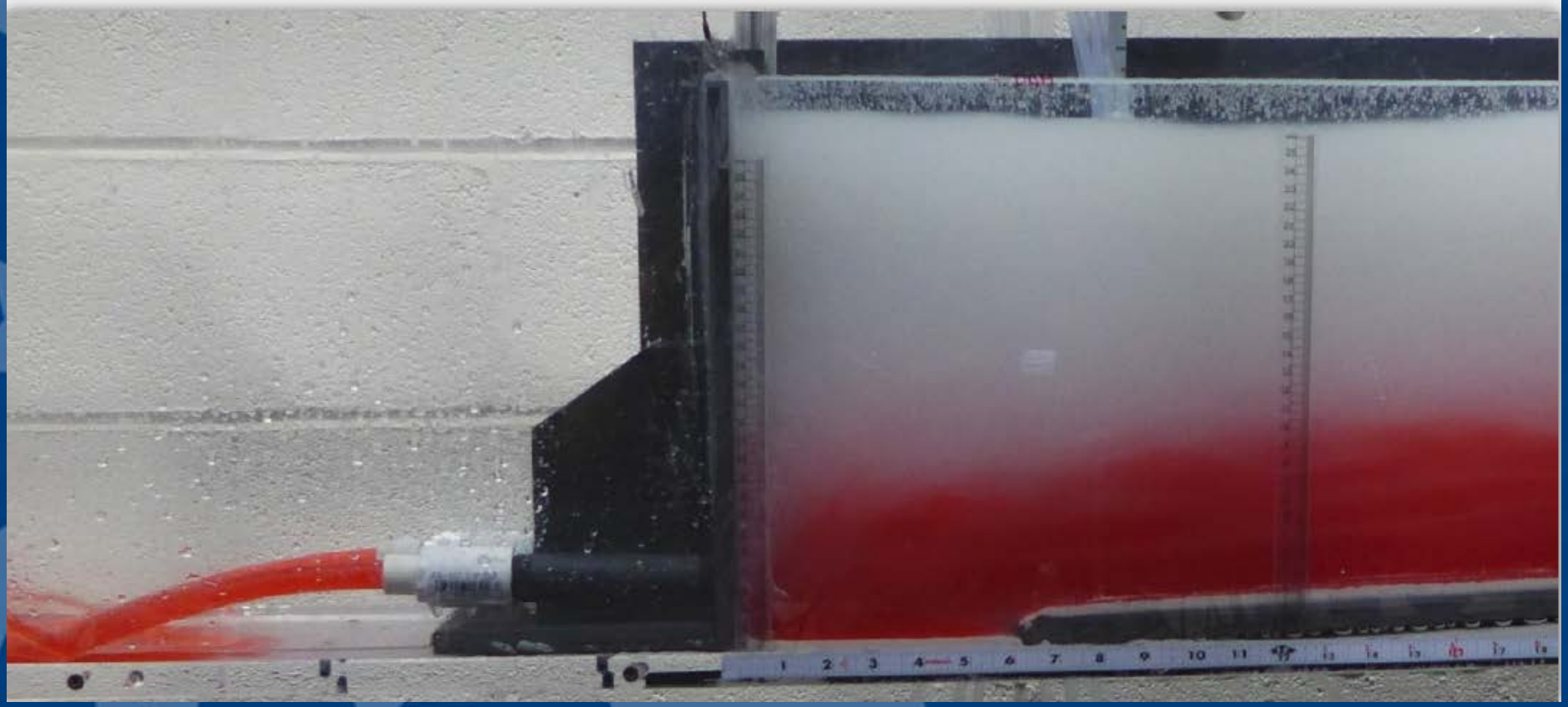
Water Injection Dredging

- The process of hydraulically assisting the creation of a turbid density current or “turbidity current”



*Graphic courtesy of U.S. Corps of Engineers

Density Current Venting



*Courtesy of U.S. Corps of Engineers

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Occur in nature at some reservoirs

Idea with WID: Hydraulically assist the formation of density currents

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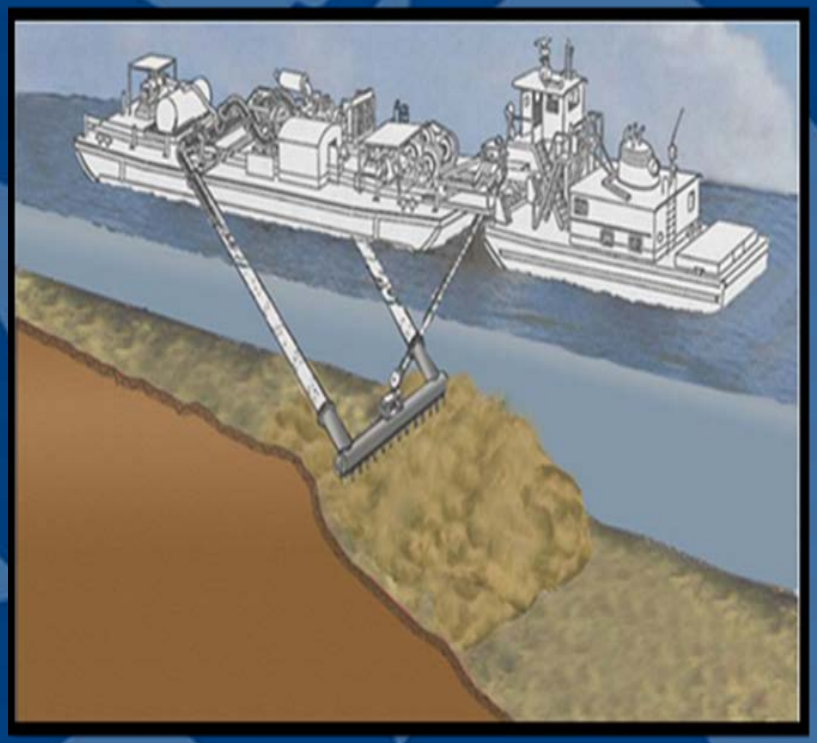
Water Injection Dredging



- Inject water into the sediment deposits to induce a density current.
- Open the gates and release the sediment through the existing conduit.

https://www.youtube.com/watch?v=JfVK5rLYXiM

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Water Injection Dredge (WID)

Weeks Marine BT 773

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Where has WID been used?

Traditional Operations
Private Dock Work
Mississippi River
- Grain Dock –Convent, LA
- Refinery –Baton Rouge, LA
- Refinery –Sunshine, LA
- Grain Dock –Destrehan, LA
- Chemical –Plaquemines, LA
- Refinery –St. James, LA
- Barge Dock -Jefferson, LA
- Refinery –St. James, LA
- Refinery –Jefferson, LA
- Refining Facility –Baton Rouge, LA
- Agricultural –Jefferson, LA

Atchafalaya River
- Refinery –Krotz Springs, LA

Federal Navigation

New Orleans District
- New Orleans Harbor
- Michoud Canal
- Miss. River Gulf Outlet
- E & W Calumet Floodgates
- Tiger Pass Channel

Galveston District
- Houston Ship Channel
- Bayport Ship Channel

Mobile District
- Horn Island

Note: No reservoirs are on the list

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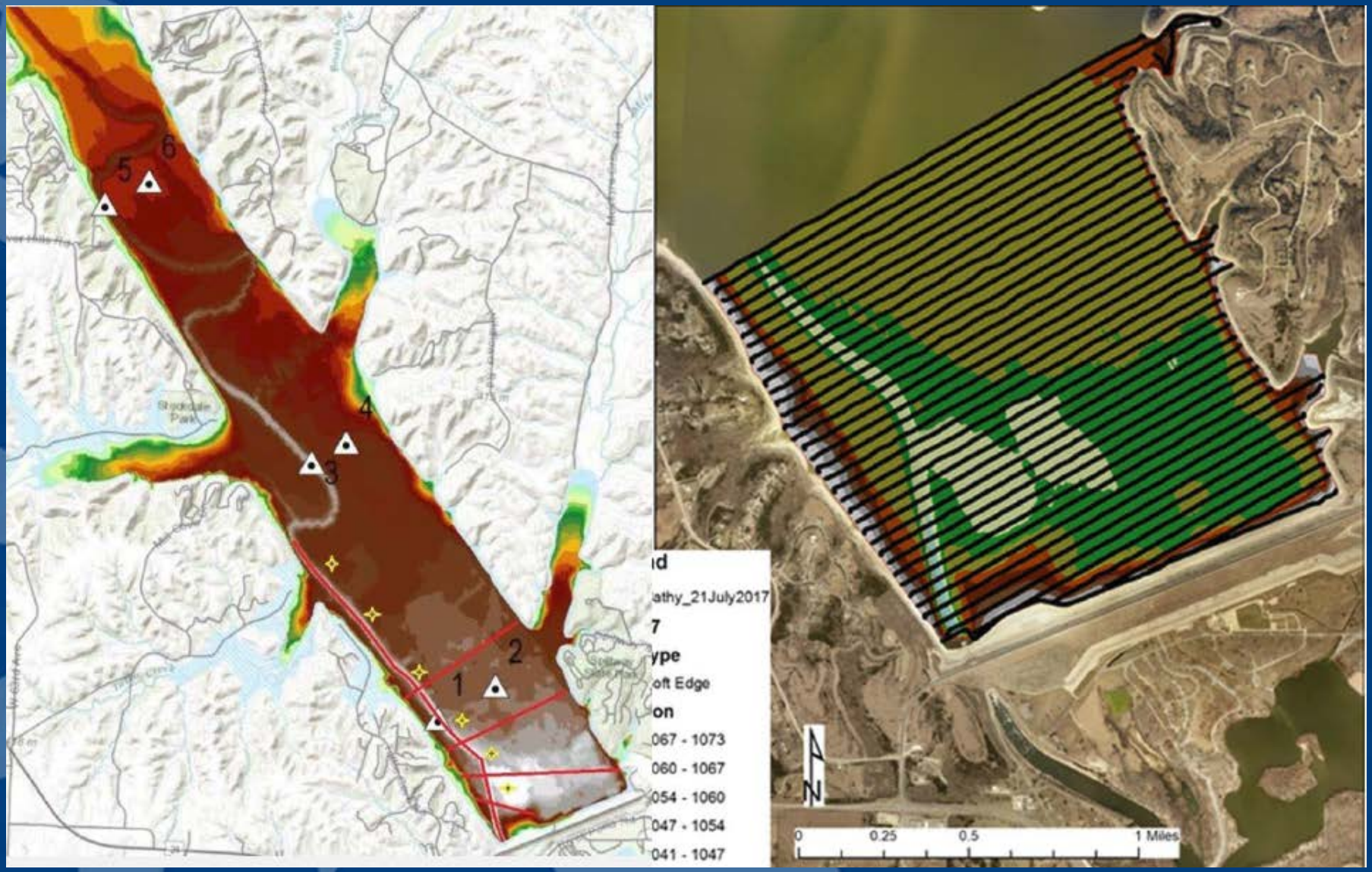
ERDC Research Unit on Water Injection Dredging

1) Develop laboratory procedure for evaluation potential for site-specific sediments to be fluidized using the WID process;
2) Develop a suite of field tools that can be applied to evaluate sediment bulk properties at a site;
3) Utilizing bulk property data and laboratory testing, develop a screening matrix of sediment properties and site characteristics favorable for fluidization;
4) Develop a screening-level numerical model that identifies the potential for WID fluidized sediments to be transported as a density current under site-specific sediment, bed slope and hydrodynamic conditions;
5) Develop technical guidance describing field, laboratory, and numerical model application to evaluate potential use of WID at a site; and
6) Foster private industry/government collaboration to build WID infrastructure applicable to reservoir sediment management.



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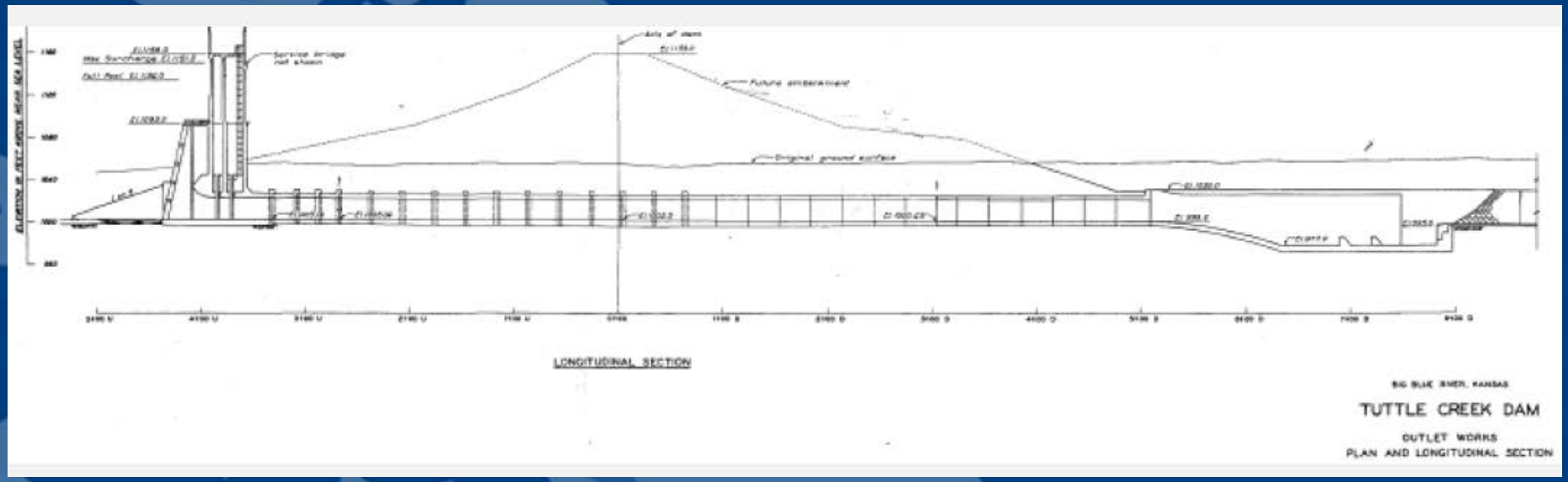
Operate WID to Coincide with Normal Releases



Current Efforts

KWO and Corps PAS Agreement:

- Sediment Transport Model of Kansas River - cross sections & LiDAR
- Velocity Measurements (ADCP) at transects and in original channel (KWO/KSU)
- Sediment Cores & bed samples (KWO/KUCR) to ERDC for analysis
- WQ samples (KWO/KDHE)

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Current Efforts

KWO and Corps PAS Agreement:

- Monitoring Plan development
  - KWO, Corps, partner agencies, others
- Communication & Outreach
  - Agency partners, downstream stakeholders

→ Path to WID Demonstration at Tuttle Creek Lake

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Section 1122 Proposal:
Tuttle Creek Lake Water Injection Dredging (WID)

Purpose and Cost

- *Estimated Operational Costs = $1,332,500*
- *Estimated Monitoring Costs = $55,000*
- Sustain reservoir storage pool capacity for navigation releases
- Promote public safety
- Protect, restore and create aquatic ecosystem habitats
- Promote recreation
- Reduce the costs of dredging and dredged material placement, such as project that use dredged material for:
  - Other innovative uses and placement
  - Reduce operation and maintenance costs for the reservoir due to sedimentation impacts

Monetary and Non-Monetary Benefits

- Increased storage capacity of Tuttle Creek
  - Navigation releases
  - Water supply/drought resiliency/flood mitigation
- Improved downstream aquatic habitat conditions
- Improved in-lake recreation through:
  - Increased water depth for boating and fishing
  - Improved water quality
- Template for WID technology elsewhere

Dredged Material Beneficial Uses

- ✓ Promoting public safety by increasing and sustaining water supply storage in Tuttle Creek Lake, a vital water supply source for downstream users
- ✓ Sustaining reservoir storage for navigation releases
- ✓ Protecting, restoring and creating aquatic ecosystem habitats through improved water quality and quantity for downriver releases during drought conditions in the region of the Kansas River.
- ✓ The ability to release more turbid water to aid in the restoration of historic fish species and other aquatic wildlife below Tuttle Creek Dam.
- ✓ Promoting recreation through increased water depth on Tuttle Creek Reservoir resulting from the dredging to improve lake-based recreation uses such as boating, water skiing and fishing.
- ✓ Reducing the costs of dredging and dredged material placement that would be required under conventional dredging based on historic conventional dredging costs of $6.67 per cubic yard.

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Urgency?

Variation in Erodibility vs. Depth

- Tests indicates that deeper (older) deposits are up to 200 times less erodible
- The longer we wait, the more difficult the sediment is to erode
- Significantly easier (less expensive) to prevent or remove new deposits than to recover storage later

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Questions?

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