

# Evaluating Comprehensive Benefits

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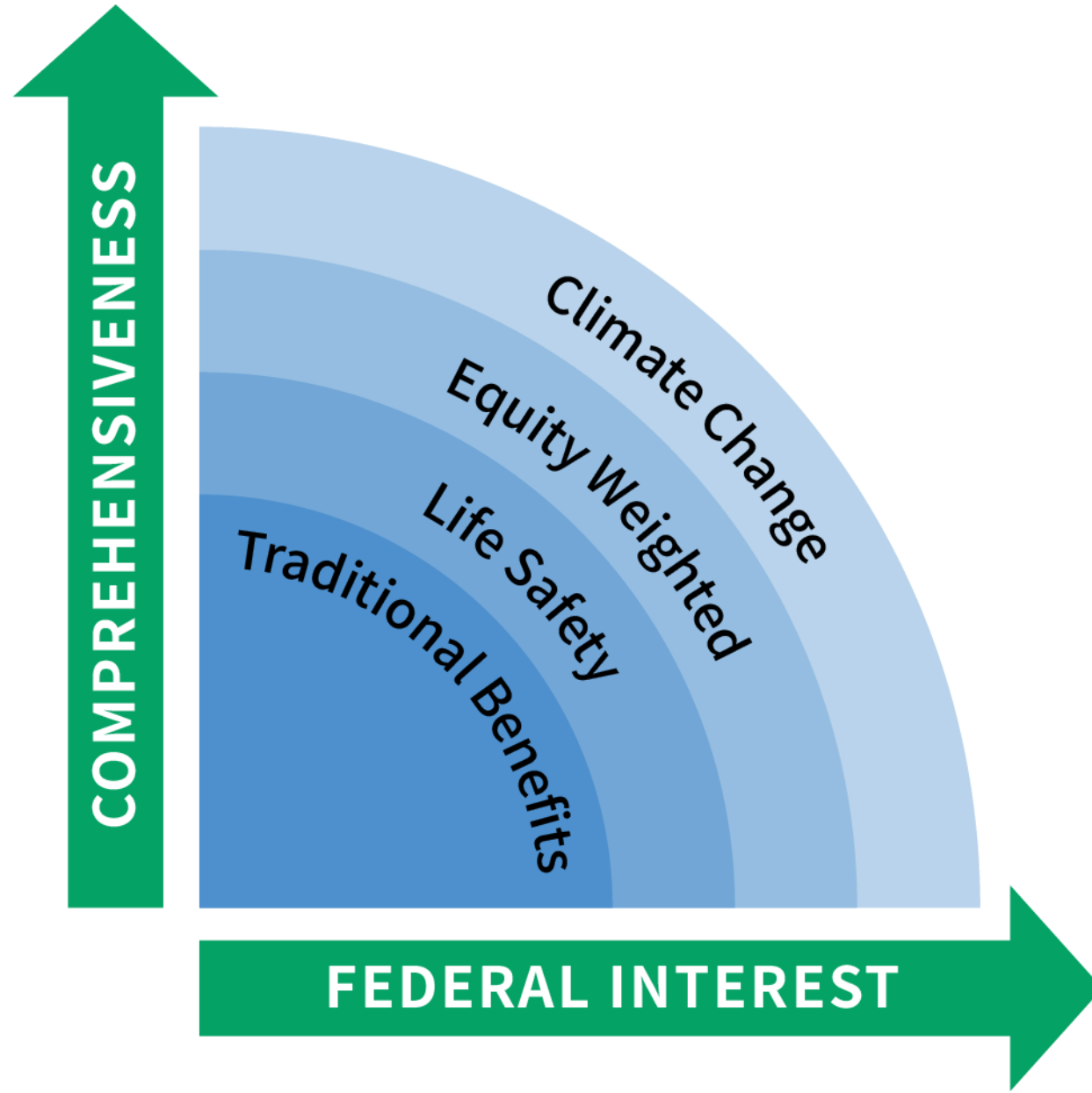
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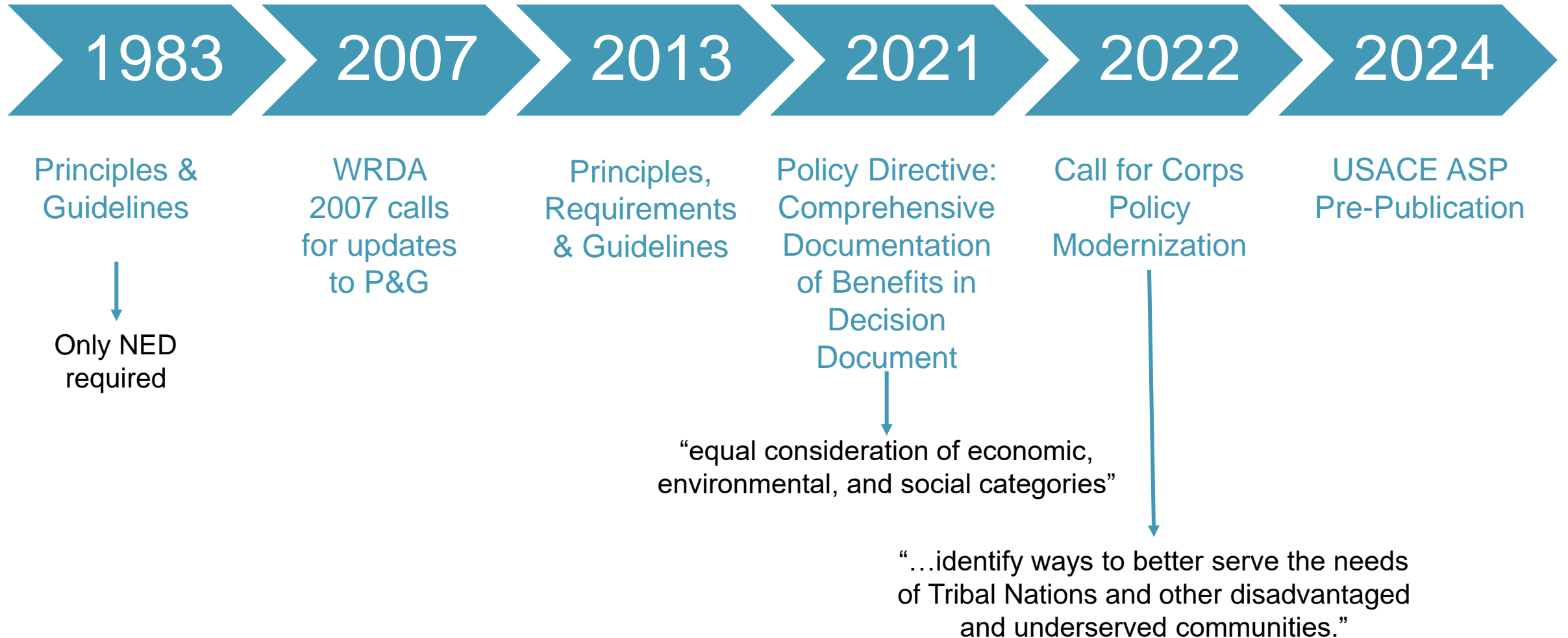
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# Roadmap to Comprehensive Benefits



# Evolving Federal Guidance Has Expanded The Scope of Evaluations That Define Federal Interest

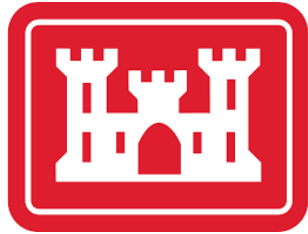


**“We are committed to integrating economic, environmental, and social benefits into our planning and improving the Corps’ ability to build resilience in a broad range of communities, including rural, tribal, and low-income areas.”**

**- Michael Conner, ASA**

*USACE ASP Pre-Publication*

# Guidance on Incorporating Equity



“...the Corps may include an **additional analysis of the benefits using distributional weights** to inform investment decisions ... [to] provide a **more equitable way to measure the welfare impacts** of these projects.”



Office of Management and Budget

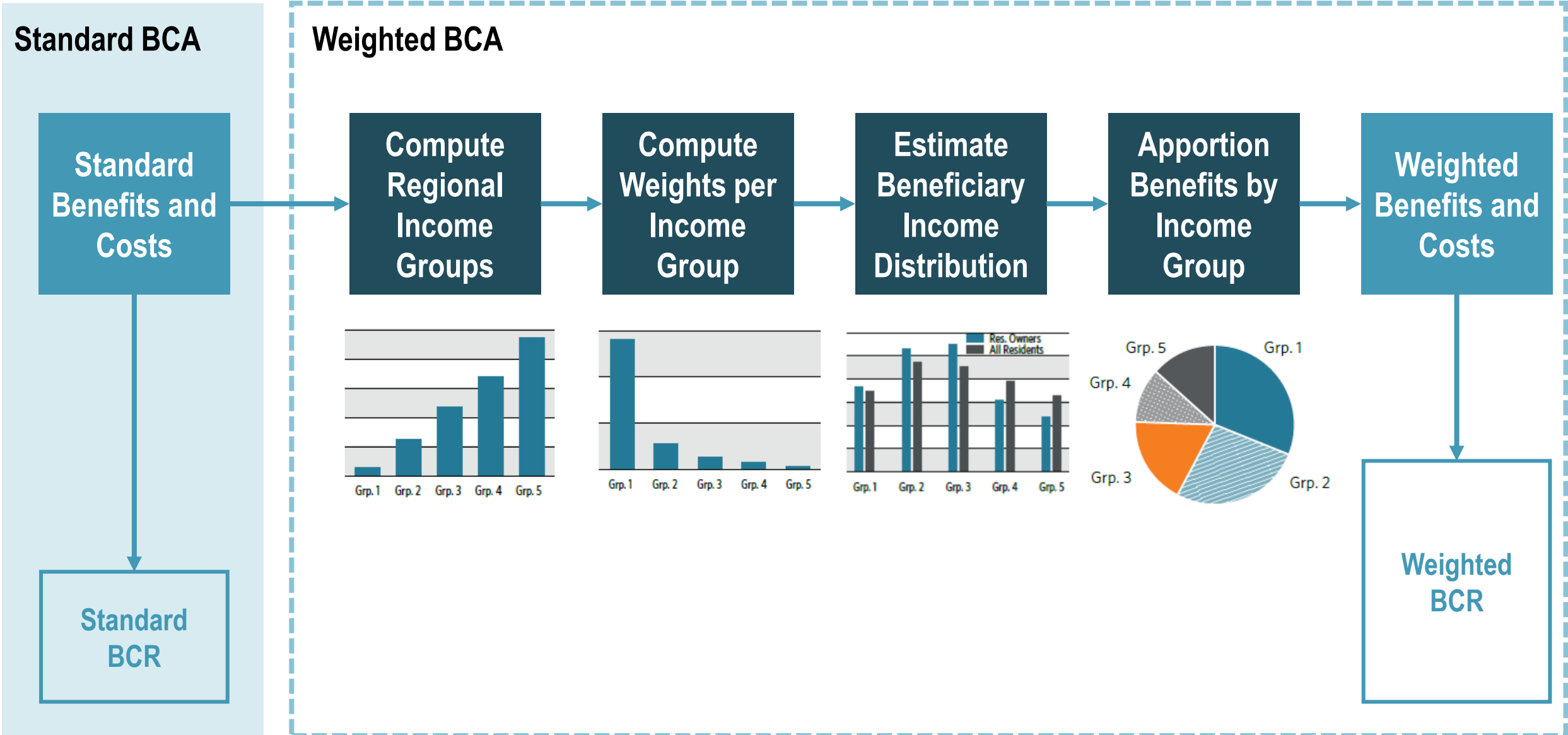
“to **select an alternative with lower monetized net benefits** over another with higher monetized net benefits because of [...] **how those net benefits are distributed**”



FEMA

“The **distributional weights will automatically adjust** the BCA results [in BCA Toolkit] ... These benefits will **make it easier for projects in disadvantaged communities to be eligible** for mitigation grant funding.”

# Weighted Benefit Cost Analysis Approach



transparent

modern

multi-benefit

# COMPREHENSIVE BENEFITS

NED

OSE

EQ

RED

modern

holistic

best available science



# Comprehensive Benefits

How will it all come together?

- Multi-Criteria Decision Analysis
- Other Evaluation Frameworks
- Tradeoff Analysis



# What does this mean for local agencies?

- Opens the door to incorporating new ideas and approaches
- Places environment and social benefits on equal footing with economic benefit
- Project evaluation may include multiple benefits
- Better reflect community needs



**How can local agencies work with USACE to  
develop and implement these innovative  
methods?**

# Case Studies: Sacramento County, CA and Harris County, TX



# SAFCA Goals and Approach

SAFCA has implemented **70 miles of levee upgrades** and helped to secure **over \$4 billion** in funding to move the regions flood protection from 70-year to nearly 250-year level of protection.

- Long-term goal to provide additional protection by:
  - Widening **Weirs and Bypasses**
  - Completing **Levee and Channel Improvements**
  - Utilizing **Upstream Reservoirs** to improve flood storage



# Yolo Bypass Overview

- West of Sacramento, CA
- Key feature of Sacramento River Flood Control Project
- 40-mile-long federal flood management facility
- Authorized in 1917
- Multi-purpose including flood, habitat, agriculture, recreation, water supply, drought resilience
- Aging infrastructure in need of modification





# Yolo Bypass Comprehensive Study

- Authorized in WRDA 2020
  - flood risk management, ecosystem restoration, water supply, and recreation
- Given study-specific guidance
- Comprehensive Study is a newer approach



U.S. Army Corps of Engineers  
Sacramento District



STATE OF CALIFORNIA  
CENTRAL VALLEY  
FLOOD PROTECTION BOARD



CALIFORNIA DEPARTMENT OF  
WATER RESOURCES

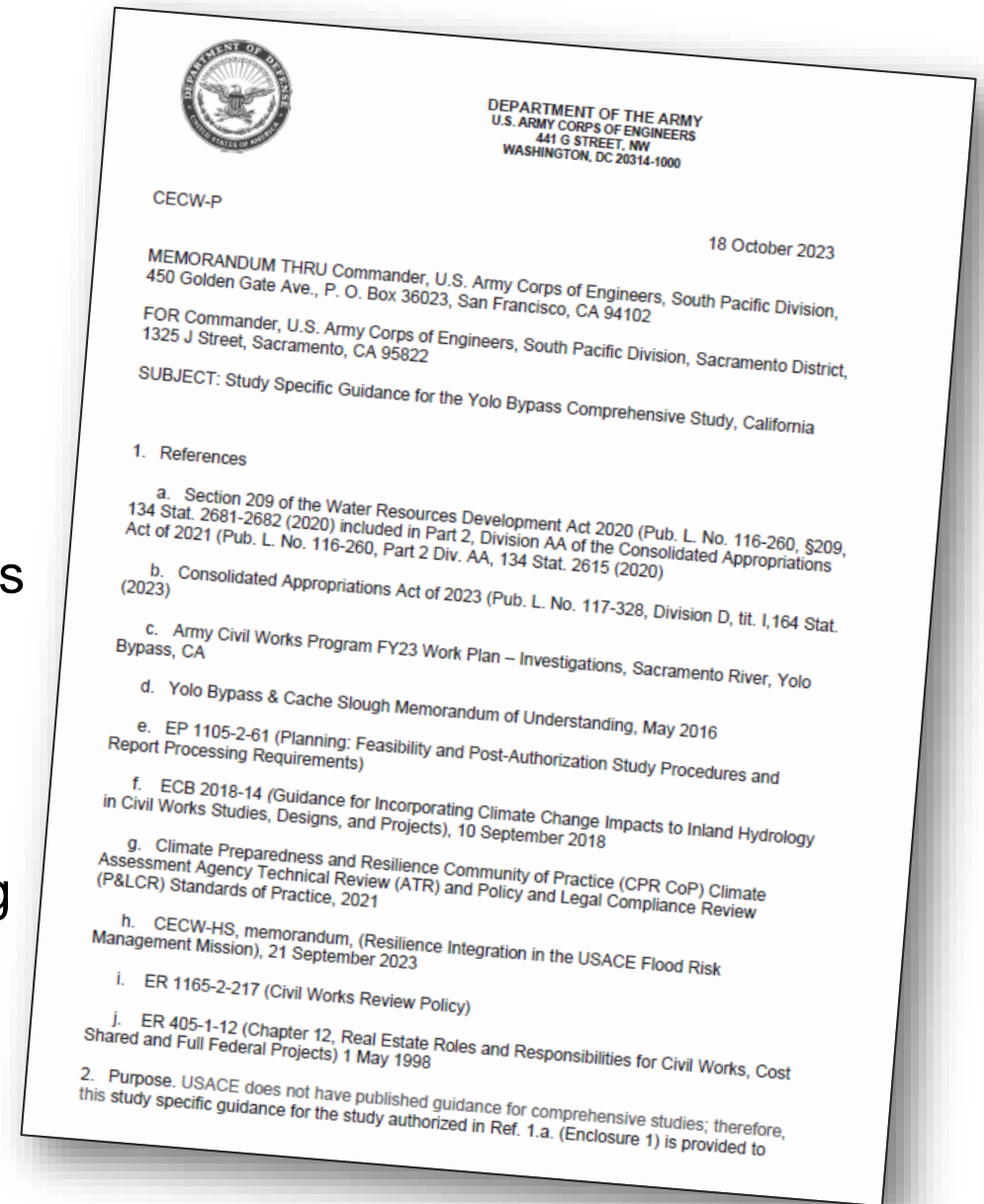
Flooded Yolo Bypass



# STUDY SPECIFIC GUIDANCE



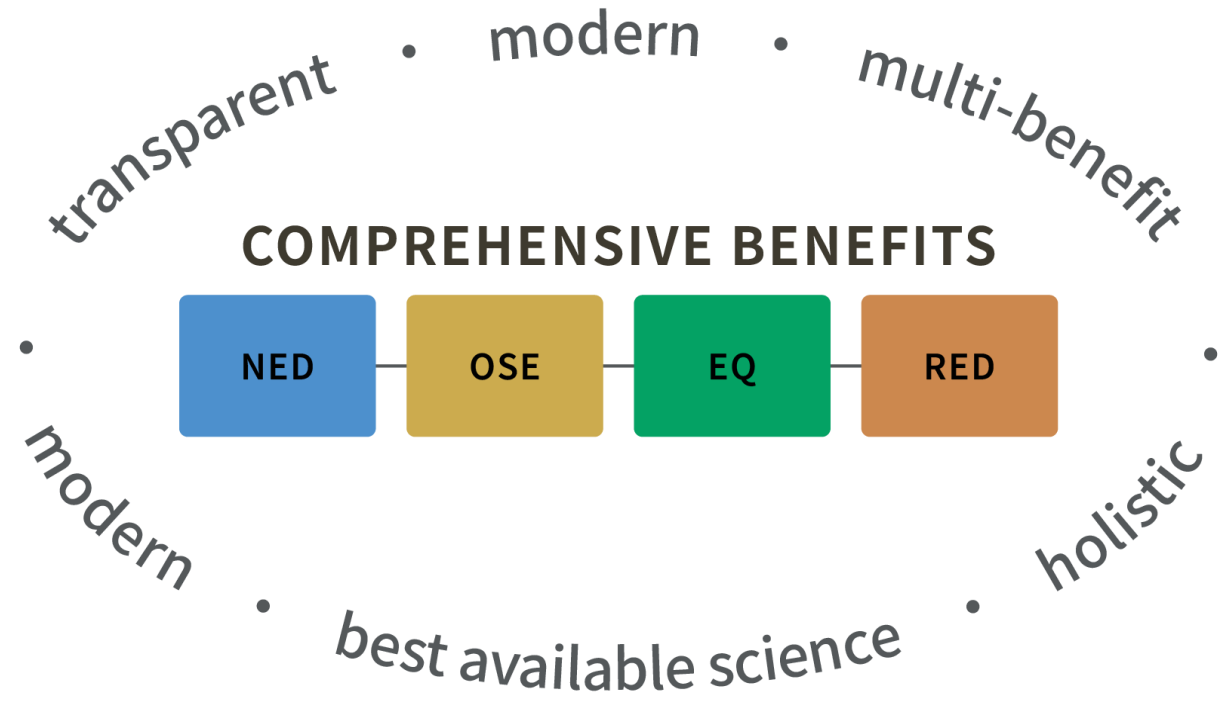
- **Comprehensive-Level Approach (Comprehensive Management Plan)**
  - System-wide, programmatic strategies
  - Developed at a comprehensive level of detail
  - Includes items such as O&M, monitoring, pilots
  
- **Feasibility-Level Approach**
  - New features
  - Structural or operational modification of existing features
  - **To include comprehensive benefits**
  - Developed at feasibility level of detail
  
- **Recommendations for future feasibility studies**
  - Based on plan formulation development and screening
  - Described at a coarse-level detail





# Study Specific Guidance: Benefits Evaluation

- NED benefits
- FRM measures that are nature-based, such as ecosystem restoration & ecosystem services
- Plans that reduce life risks - life safety (OSE)
- Loss of service to critical facilities (OSE)
- Drought resiliency (OSE)
- **Benefits to economically disadvantaged communities (OSE)**
  - **Weighted Benefit-Cost Analysis**  
Accounts for the value of avoided damage to disadvantaged communities



# Equity Considerations within the Yolo Bypass

105

Disadvantaged Communities census tracts

503,234

People living in Disadvantaged communities

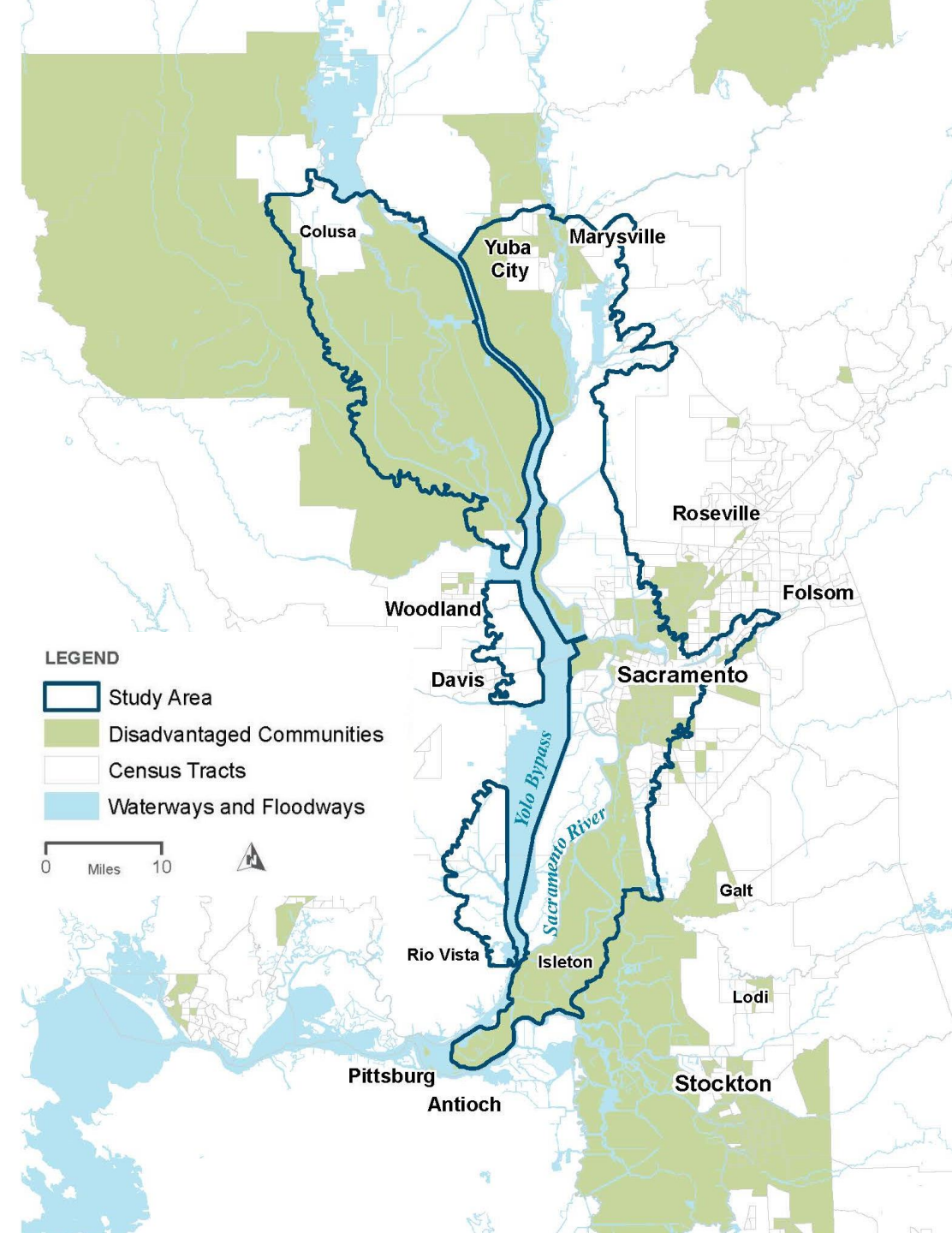
2-2.5x

Preliminary results from the weighted BCA show a benefit cost ratio that is an order of magnitude higher than the standard approach

Data Source:



Climate and Economic Justice  
Screening Tool



# Comprehensive Benefits and the Yolo Bypass

- Weighted BCA is a credible and practical approach to quantify Other Social Effects
- Tested methods fall within USACE guidelines
- Can serve both federal and NFS interests in risk reduction for disadvantaged communities while supporting implementation of
  - Draft ASPs
  - 2021 Interim Guidance
  - PR&G

# Yolo Bypass Comprehensive Study

- Next Steps:
  - Promote use of both a traditional BCA and a Weighted BCA
  - **Engage USACE Staff/HQ & provide Yolo pilot example**
  - **Develop a plan that maximizes net total benefits across all benefit categories**
  - Formalize a standard approach to Weighted BCA analysis in planning studies





# National Waterways Conference: Maximizing Comprehensive Benefits

Scott Elmer, P.E. | Chief of Partnerships and Programs

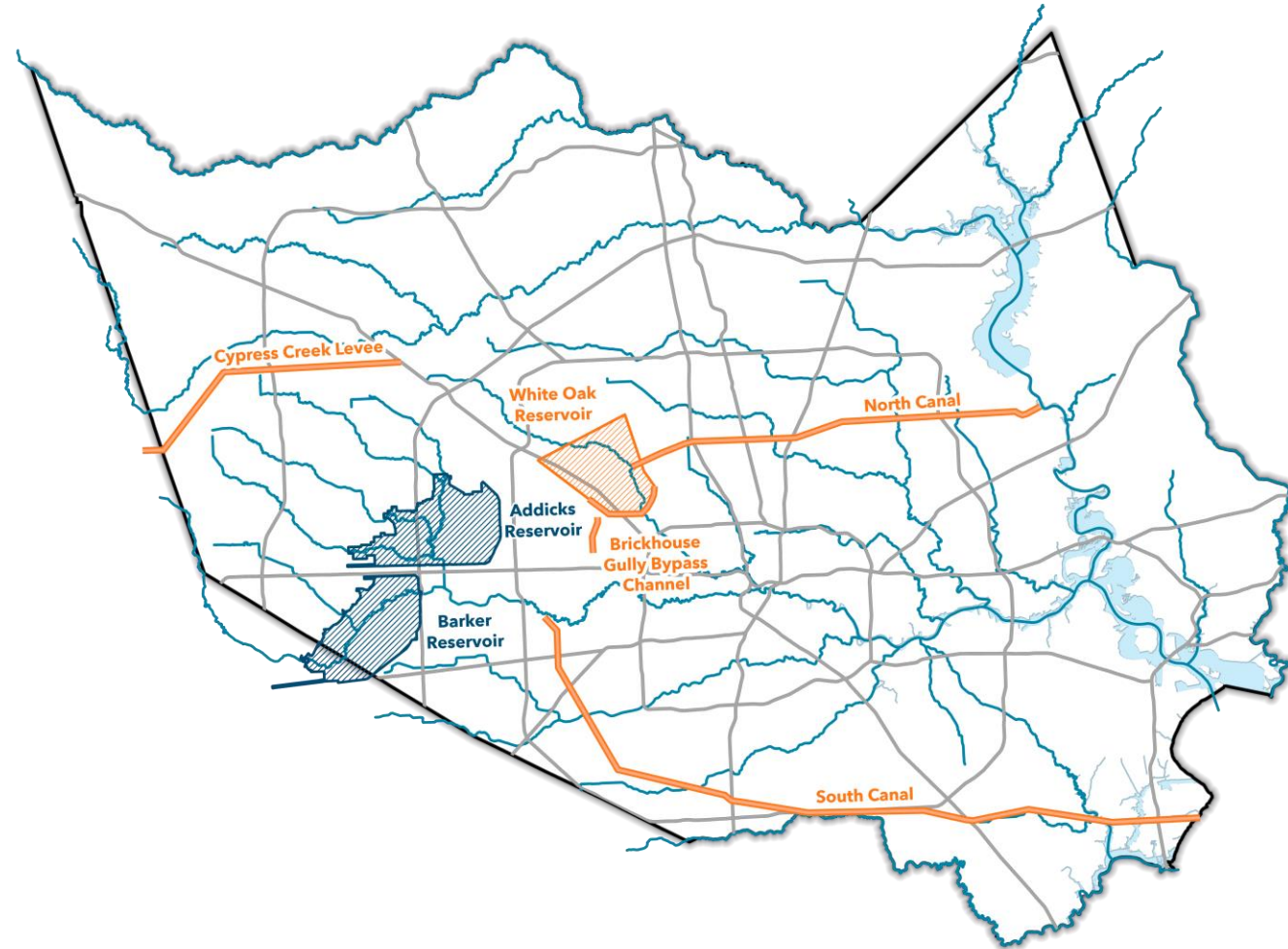
## Our Mission

To **plan and deliver** effective flood risk reduction projects guided by **community and natural values** while **maintaining** our infrastructure

# TIMELINE OF EVENTS

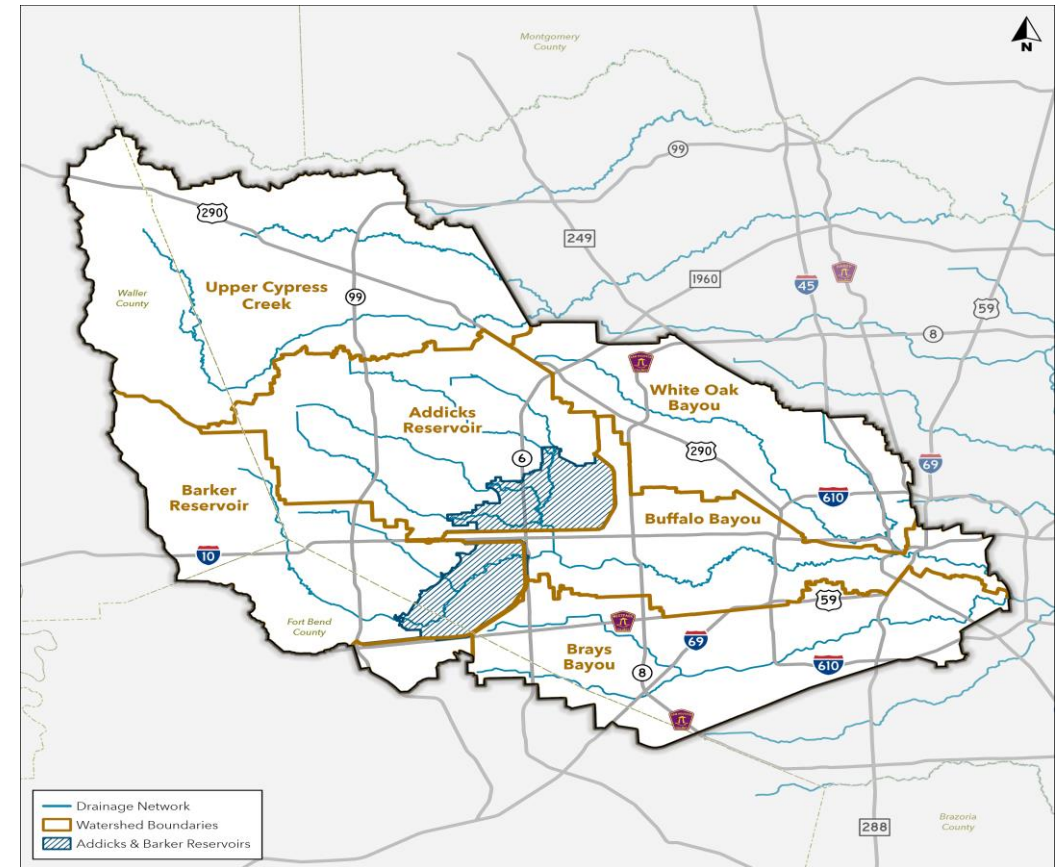
- Early Flooding (1929 / 1935)
- Buffalo Bayou & Tributaries Project
- Tax Day Flood (2016)
- Hurricane Harvey (2017)

## Buffalo Bayou & Tributaries Project



# Study Overview

- **Authorization:** Section 216 of the FCA of 1970
- **Appropriation:** Bipartisan Budget Act of 2018
- **Budget:** \$7.8 Million (100% federal) with contributed technical services from HCFCD
- **Purpose:** Flood Risk Management
- **Non-Federal Sponsor:** HCFCD
- **Study Objectives:**
  - Reduce life safety risks associated with Addicks and Barker
  - Reduce flood risks / damages upstream and downstream of Addicks and Barker
  - Support community resilience and recovery



Buffalo Bayou and Tributaries, and Texas Resiliency Study



# Shared HCFCD / USACE Priorities

4.7M+

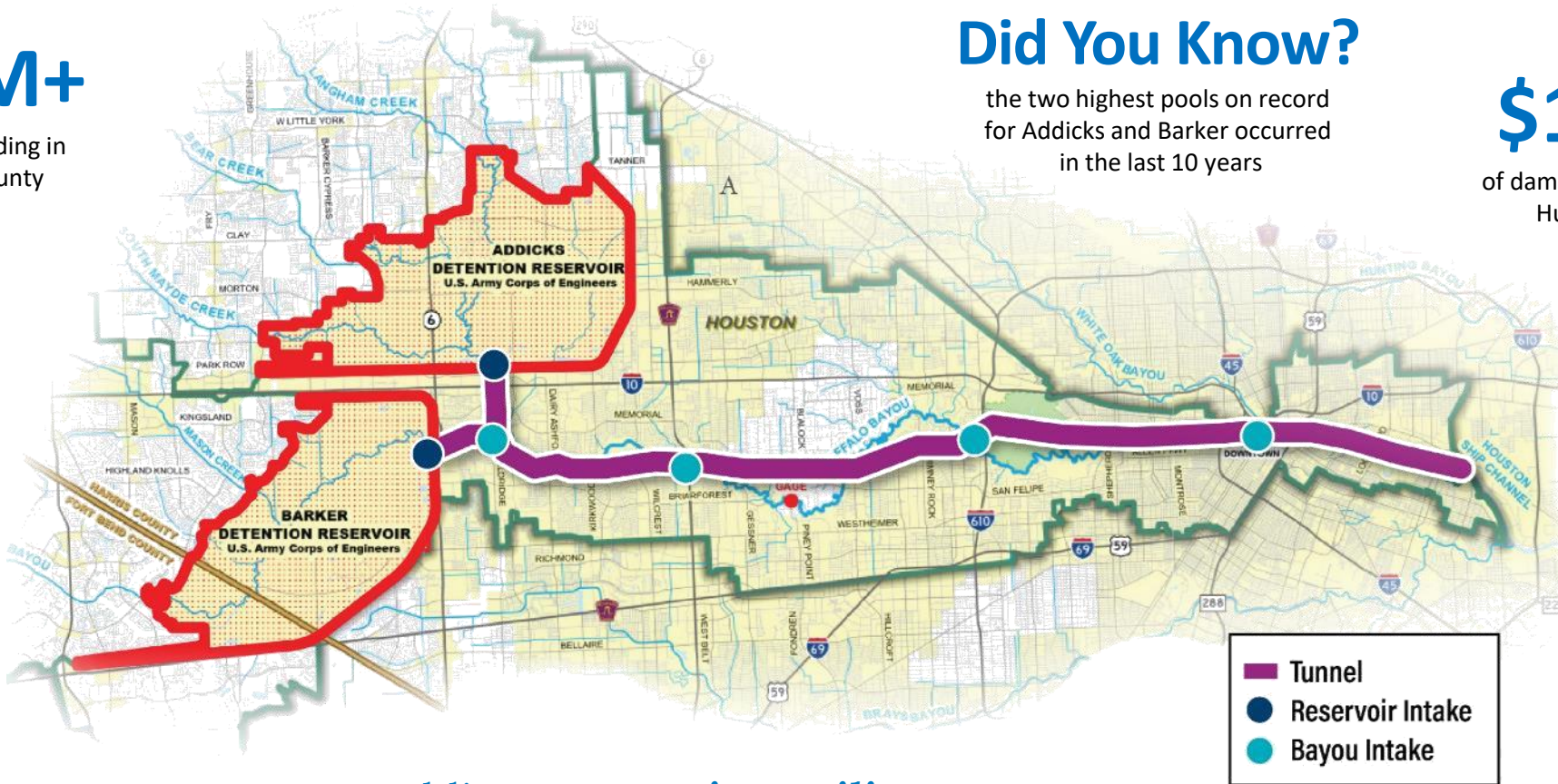
people residing in Harris County

43.4%

of Harris County residents are Low-to-Moderate Income

4<sup>th</sup>

largest city in the U.S. is located immediately downstream of the Addicks and Barker Reservoirs



## Did You Know?

the two highest pools on record for Addicks and Barker occurred in the last 10 years

\$125B+

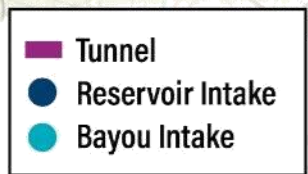
of damages incurred during Hurricane Harvey

30%

increase in design rainfall intensity between TP-40 and Atlas 14

25,000

structures flooded upstream and downstream of Addicks and Barker during Hurricane Harvey




- Focus on enabling *community resilience*
- Better serve the needs of *disadvantaged* communities
- Be *innovative* in developing new strategies to build *climate resilience*
- *Solve* pressing water resources challenges


# BBTRS WORK PRODUCTS

SECTION 216 INVESTIGATION OF COMPLETED WORKS  
**BUFFALO BAYOU AND TRIBUTARIES  
RESILIENCY STUDY**  
INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL  
IMPACT ASSESSMENT

HYDROLOGY & HYDRAULIC APPENDIX  
**PRELIMINARY - ATR SUBMITTAL**  
AUGUST 9, 2023



PREPARED FOR  
HARRIS COUNTY FLOOD CONTROL DISTRICT  
AND  
U.S. ARMY CORPS OF ENGINEERS - GALVESTON DISTRICT




SECTION 216 INVESTIGATION OF COMPLETED WORKS  
**BUFFALO BAYOU AND TRIBUTARIES  
RESILIENCY STUDY**

DRAFT FEASIBILITY REPORT

ENVIRONMENTAL INFORMATION

August 30, 2023

PREPARED FOR  
HARRIS COUNTY FLOOD CONTROL DISTRICT  
AND  
U.S. ARMY CORPS OF ENGINEERS - GALVESTON DISTRICT



SECTION 216 INVESTIGATION OF COMPLETED WORKS  
**BUFFALO BAYOU AND TRIBUTARIES  
RESILIENCY STUDY**

DRAFT FEASIBILITY REPORT

COMPREHENSIVE BENEFITS ANALYSIS  
**PRELIMINARY - DOC SUBMITTAL**


October 11, 2023

PREPARED FOR  
HARRIS COUNTY FLOOD CONTROL DISTRICT  
AND  
U.S. ARMY CORPS OF ENGINEERS - GALVESTON DISTRICT




SECTION 216 INVESTIGATION OF COMPLETED WORKS  
**BUFFALO BAYOU TRIBUTARIES  
RESILIENCY STUDY (BBTRS)**  
BUFFALO BAYOU TUNNEL  
INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL  
IMPACT ASSESSMENT

ENGINEERING APPENDIX  
**PRELIMINARY - TARGETED ATR SUBMITTAL**  
AUGUST 4, 2023



PREPARED FOR  
HARRIS COUNTY FLOOD CONTROL DISTRICT  
AND  
U.S. ARMY CORPS OF ENGINEERS - GALVESTON DISTRICT




SECTION 216 INVESTIGATION OF COMPLETED WORKS  
**BUFFALO BAYOU AND TRIBUTARIES  
RESILIENCY STUDY**

DRAFT FEASIBILITY REPORT

ECONOMIC AND SOCIAL BENEFITS APPENDIX  
**PRELIMINARY - ATR SUBMITTAL**

September 20, 2023

PREPARED FOR  
HARRIS COUNTY FLOOD CONTROL DISTRICT  
AND  
U.S. ARMY CORPS OF ENGINEERS - GALVESTON DISTRICT



# ECONOMIC RESULTS (NED)

	A&B (Dam Safety Benefits)	Upper Buffalo (Main Benefit Zone)	Lower Buffalo / White Oak (EJ Benefits)	OVERALL AAEB
Operational Scenario 1	~\$25M AAEB (~\$40M AAEB)	Negligible AAEB	Negligible AAEB	\$25M (\$40M)
Operational Scenario 2	~\$20M AAEB (~\$25M AAEB)	~\$80M AAEB (\$115M AAEB)	Negligible AAEB	\$100M, 0.33 BCR (\$140M, 0.46 BCR)
Operational Scenario 3	Negligible AAEB	Negligible AAEB	~\$10M AAEB (~\$30M AAEB)	\$10M (\$30M)

ANTICIPATED  
BCR RANGE

0.33 to 0.62  
+ / -

Subject to:

- ↔ Climate change assumptions
- ↔ Cost contingency / risk
- ↑ Further optimization
- ↑ Operating assumptions

**BLACK:** Modeled Results    **RED:** Estimated (Results Pending)  
**YELLOW:** Primary Gate Operation    **GREEN:** Secondary Gate Operation  
 Note: w/o future rainfall (w/future rainfall) \*\*\* Methodology discussion in progress

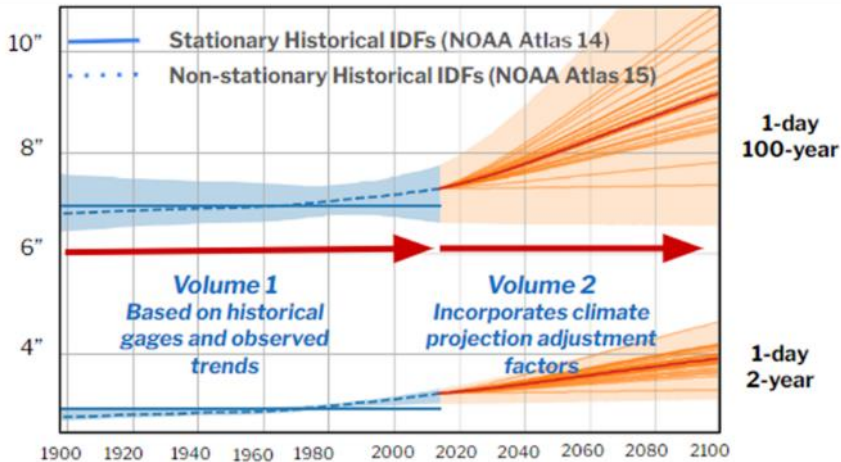
**Potential\*\*\*\***  
 \$115M, 0.39 BCR  
 (\$185M, 0.62 BCR)

# CBA Framework/ Themes

## ADAPTING TO CLIMATE CHANGE

Previous TP-40 100-yr Rainfall **13" /24 hours**  
 New ATLAS 14 100-yr Rainfall **17" /24 hours** **30% INCREASE**

NOAA Atlas 15



## PROMOTING RESILIENCY

### RESILIENCY

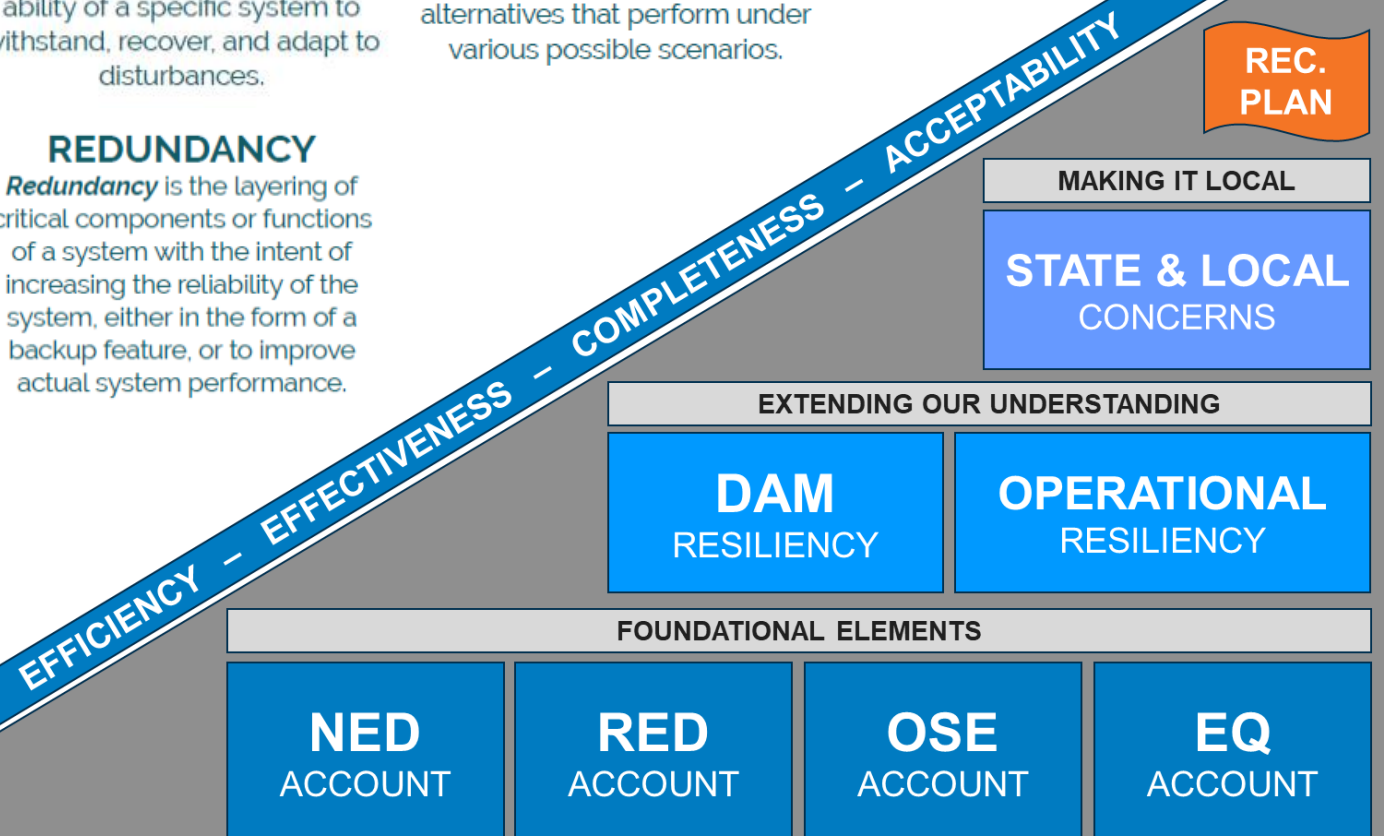
*Resiliency* is multifaceted and can best be defined as the ability of a specific system to withstand, recover, and adapt to disturbances.

### ROBUSTNESS

*Robustness* is an opportunity to formulate measures within the alternatives that perform under various possible scenarios.

### REDUNDANCY

*Redundancy* is the layering of critical components or functions of a system with the intent of increasing the reliability of the system, either in the form of a backup feature, or to improve actual system performance.



# October 2023 – CoP Guidance



## DISPLAYING THE RESULTS OF ALTERNATIVES EVALUATION AND COMPARISON: “TABLE OF EFFECTS”

### INTRODUCTION

A pre-publication draft of the Policy for Conducting Civil Works Planning Studies was widely distributed to the Planning Community of Practice in March 2023. Although it has not yet been officially published, the Planning Community of Practice is seeking to provide resources and training to aid in the implementation of the policy so that it can be effectively employed once it becomes official guidance.

This document provides examples of a “Table of Effects” that meets the intent of the draft policy. There are many methods for meeting the requirements, and while the tables illustrated here provide examples, they are not intended to be prescriptive or stifle creativity.

USACE’s planning teams are encouraged to use these tables for inspiration and develop their own methods based on the needs of their studies.

### ACKNOWLEDGEMENTS

The USACE Planning Community of Practice wishes to thank and recognize Tim Fleeger from the Northwestern Division and Aubree Hershorn from the Jacksonville District for leading the effort to understand and develop these “Table of Effects” examples.

### RELEVANT SECTIONS OF THE DRAFT POLICY

The Policy for Conducting Civil Works Planning Studies discusses a “Table of Effects” as a requirement within a feasibility report that presents the alternatives being considered.

Paragraph 2-4e(3) elaborates on the expectations for the Table of Effects:

“Planning teams will display the results of the evaluation process in a table of effects, supported by charts, illustrations, photos, and summary statements as needed to objectively describe the contributions of each alternative, including the no action alternative, to the Federal Objectives and each of the Guiding Principles. The table of effects should present the performance of each alternative, relative to the baseline, the study objectives, the four formulation and evaluation criteria, and any other screening or selection criteria used in the analyses.”

The categories and fields in the “Table of Effects” examples (provided in this document), are based on other mentions of the “Table of Effects” in the policy, and the requirements for alternative formulation, evaluation, and comparison.

Paragraph 2-4d(2) discusses the formulation and evaluation of alternatives:

“The formulation and evaluation of alternatives must contain sufficient detail to be useful in decision making and must assess, document, and communicate:

- (a) How comprehensive benefits of an alternative compare to its risks, costs, and impacts;
- (b) How alternatives perform with respect to the Federal Objectives and Guiding Principles; and
- (c) How alternatives perform against the four formulation and evaluation criteria: completeness, effectiveness, efficiency, and acceptability.”

Paragraph 2-4c(6) discusses the array of alternatives to be evaluated and clarifies that one plan can satisfy multiple requirements:

“To facilitate discussion and evaluation of the trade-offs among the four Principles and Guidelines (P&G) accounts – National Economic Development, Regional Economic Development, Other Social Effects and Environmental Quality (NED, RED, OSE, EQ) – the array of alternatives must include, at a minimum, the following plans for evaluation. Among the multiple plans developed during formulation, the same alternative may be identified to meet more than one of the required plans listed below.

- (a) The “no action” alternative.
- (b) An NED or National Ecosystem Restoration (NER) plan.
- (c) A plan that reasonably maximizes total net benefits across all benefit categories including monetized and non-monetized benefits.
- (d) A plan that reasonably maximizes net benefits including monetized and non-monetized benefits consistent with the study purpose only.
- (e) The least environmentally damaging practicable alternative, as required by the Clean Water Act under Section 404 (40 CFR Part 230).
- (f) For flood risk management studies, a nonstructural plan that includes modified floodplain management practices, elevation, relocation, buyout/acquisition, dry flood proofing, and wet flood proofing.
- (g) A locally preferred plan (LPP), if requested by the non-federal partner and approved by the Assistant Secretary of the Army (Civil Works), if the LPP is not one of the plans identified above.”

## INFORMATION TO BE INCLUDED IN THE “TABLE OF EFFECTS”

Taken together, the relevant sections of the draft policy indicate that a “Table of Effects,” supported by charts, illustrations, photos, and summary statements, should display the following information for each of the alternatives:

- **Cost**
- Performance with respect to the **Federal Objectives (WRDA 2007)**
  - Seeking to maximize sustainable economic development
  - Seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used
  - Protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems
- Performance with respect to the **Guiding Principles (CEQ 2014 Principles, Requirements, and Interagency Guidelines)**
  - Healthy and Resilient Ecosystems
  - Sustainable Economic Development
  - Floodplains
  - Public Safety
  - Environmental Justice and Equity
  - Watershed Approach
- Performance with respect to the **four formulation and evaluation criteria (1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies)**
  - Completeness
  - Effectiveness
  - Efficiency
  - Acceptability
- Performance with respect to study specific **planning objectives**
- Performance with respect to any other **screening and selection criteria**
- Performance with respect to the **study specific metrics, as organized by the four accounts**
  - Regional Economic Development (RED)
  - Other Social Effects (OSE)
- **Uncertainty** in the assessment of the performance of alternatives
  - Although not explicitly stated, it is implied that each of the “required” plans be identified in the table. Depending on the mission area and the measures under consideration, this will include some combination of the following alternatives:
    - The “No Action” Alternative (required for all studies)
    - The Total Net Benefits Plan (required for all studies)
    - The Least Environmentally Damaging Practicable Alternative (LEDPA) (required for

Table 1: Stacked Table Example as Applied to Flood Risk Management

FEDERAL OBJECTIVES	Maximize Economic Development				Avoid Unwise Use of Floodplains and Flood Prone Areas		Protect and Restore Natural Systems		EJ / Equity	Watershed Approach			
	Sustainable Economic Development				Flood plains	Public Safety	Healthy and Resilient Ecosystems						
GUIDING PRINCIPLES	Sustainable Economic Development				Flood plains	Public Safety	Healthy and Resilient Ecosystems	EJ / Equity	Watershed Approach				
PLANNING OBJECTIVES (SEE TABLE 2)	Obj 1	Obj 1	Obj 1	Obj 4	Obj 5	Obj 2	Obj 2	Obj 3	Obj 6	Obj 7			
P&G ACCOUNTS	NED	NED	NED	NED	RED	OSE	OSE	EQ	OSE	OSE			
FORMULATION/EVALUATION CRITERIA	Efficiency		Effectiveness			Effectiveness	Effectiveness	Effectiveness	Effectiveness	Effectiveness	Completeness	Acceptability	
METRICS	Cost	BCR	Annual NED Benefits	Recreation Benefits	Annual RED Benefits	Structures at Risk	Life Safety Risks Reduced	ER Benefits	EJ Benefits	Comprehensive Plan	Accounts for Necessary Investments	Implementability	Satisfaction
NO ACTION ALTERNATIVE													
ALTERNATIVE 1: ECONOMIC FOCUS <sup>1</sup>													
ALTERNATIVE 2: ENVIRONMENTAL FOCUS <sup>1M</sup>													
RECOMMENDED - ALTERNATIVE 3: SPONSOR REQUESTED <sup>1</sup>													
ALTERNATIVE 4: LIFE SAFETY FOCUS <sup>1</sup>													
ALTERNATIVE 5: BALANCED PLAN <sup>1</sup>													

Plan identification: <sup>1</sup>Total Net Benefits, <sup>1M</sup>NED Plan, <sup>1LEDPA</sup>Least-Structural Plan, <sup>1</sup>Locally Preferred Plan, <sup>1</sup>Life Safety Plan (meets TRS 1 and 4)

# CBA Matrix / Table of Effects

## BBTRS - Draft Comprehensive Benefits Matrix

September 2023

DISCLAIMER: This matrix is preliminary and should be considered a work-in-progress. All items are being refined actively.

Category	Metric	Description	Units	NO ACTION ALTERNATIVE	TUNNEL ALTERNATIVE
<b>NATIONAL ECONOMIC DEVELOPMENT (NED) ACCOUNT</b>					
Physical Damages (\$)	Structure/Content/Debris Damages	Direct structure damage for inventory assets, in addition to contents loss and debris removal costs.	\$ - AAE \$ - Single Event # - Count by type	<p><b>Addicks:</b> \$98,675,480 EAD \$787,783,440 / \$4,987,884,540 (1% AEP / 0.2% AEP single event) 4,083 / 25,257 structures (1% AEP / 0.2% AEP single event)</p> <p><b>Barker:</b> \$95,944,680 EAD \$448,723,020 / \$4,681,612,970 (1% AEP / 0.2% AEP single event) 1,981 / 9,789 structures (1% AEP / 0.2% AEP single event)</p> <p><b>Buffalo:</b> \$227,386,420 EAD \$2,590,945,950 / \$9,535,071,130 (1% AEP / 0.2% AEP single event) 4,320 / 11,534 structures (1% AEP / 0.2% AEP single event)</p> <p><b>White Oak:</b> \$81,862,610 EAD \$987,345,520 / \$2,535,719,410 (1% AEP / 0.2% AEP single event) 5,316 / 12,894 structures (1% AEP / 0.2% AEP single event)</p> <p>(Assumes 15% increase in future rainfall. Based on Future Year EAD)</p>	<p><b>Addicks:</b> \$89,189,380 EAD \$785,949,620 / \$4,451,707,250 (1% AEP / 0.2% AEP single event) 4,068 / 24,507 structures (1% AEP / 0.2% AEP single event)</p> <p><b>Barker:</b> \$87,173,220 EAD \$445,828,050 / \$3,811,390,550 (1% AEP / 0.2% AEP single event) 1,984 / 8,291 structures (1% AEP / 0.2% AEP single event)</p> <p><b>Buffalo:</b> \$144,575,470 EAD \$1,023,720,930 / \$6,113,521,090 (1% AEP / 0.2% AEP single event) 2,338 / 8,846 structures (1% AEP / 0.2% AEP single event)</p> <p><b>White Oak:</b> \$81,219,010 EAD \$983,957,350 / \$2,528,341,600 (1% AEP / 0.2% AEP single event) 5,309 / 12,858 structures (1% AEP / 0.2% AEP single event)</p>
	Vehicle Damages	Direct vehicle damage for inventory assets	\$ - AAE \$ - Single Event # - Count	<p><b>Addicks:</b> \$15,368,880 EAD \$168,386,000 / \$927,178,750 (1% AEP / 0.2% AEP single event) 8,579 / 38,921 vehicles (1% AEP / 0.2% AEP single event)</p> <p><b>Barker:</b> \$4,164,920 EAD \$8,675,800 / \$458,704,910 (1% AEP / 0.2% AEP single event) 5,084 / 16,318 vehicles (1% AEP / 0.2% AEP single event)</p>	<p><b>Addicks:</b> \$13,416,800 EAD \$168,386,000 / \$927,178,750 (1% AEP / 0.2% AEP single event) 8,579 / 38,921 vehicles (1% AEP / 0.2% AEP single event)</p> <p><b>Barker:</b> \$1,700,000 EAD \$8,675,800 / \$458,704,910 (1% AEP / 0.2% AEP single event) 5,100 / 16,318 vehicles (1% AEP / 0.2% AEP single event)</p>

**SUMMARY:**

- 103 total metrics analyzed
- 37 'Driving Metrics' identified
- Three layers of evaluation

**Bold Charge from HQ:**  
"Leave no benefits behind"

# DRIVING METRICS

## NED

- Flood Damage Avoided
- Recreational Value Loss
- Land Price Changes

## RED

- Tax Base Changes (Buyout)
- Tax Base Changes (FRM)
- Avoided Flood Impacts
- Perception & Attractiveness
- Construction Expenditures

## OSE

- Life Loss Risk / Pop. at Risk
- High Risk Transportation
- Evacuation Routes
- Recreation / Leisure / Commercial Assets – Project Footprint
- Population Displacements – Project Footprint
- Community Access / Mobility During Construction
- Impacts to Economically Disadvantaged Populations
- Benefits to Economically Disadvantaged Populations
- Habitation Loss Intensity
- Habitation Loss Scale
- Habitation Loss Duration

## EQ

- Footprint / Scale of Disturb.
- Impact to T&E Species
- Impact to Cultural Res.

## DAM RESILIENCY

- Reservoir Pool Elevations
- Maximum Release Rates
- Ratio of Release Rate to Reservoir Inflows
- Reservoir Drawdown Time
- Frequency of Emergency Spillway Utilization

## OPERATIONAL RES.

- Perf. in Back-to-Back Events
- Perf. in Geographically Variable Events
- Performance in an Uncertain Future
- Operational Robustness
- Operational Redundancy
- Operational Adaptability
- Operational Flexibility

## STATE & LOCAL

- Frequency of Adverse Outcomes
- Responsiveness to State and Local Concerns
- General Acceptability of the Proposed Action

# Tunnel Performance (4 Accounts)

**\$137M+**

AAE Benefits  
(Scenario 2)

**~100%**

Reduction in structural flooding upstream of Barker Reservoir in the 0.2% AEP Event

**~\$1B**

Land Price Change A&B Flood Pools

**~73%**

Reduction in structural flooding upstream of Addicks Reservoir in the 0.2% AEP Event

**~40**

Only ~40 Acres of total surface disturbance

**~0.5+/-**

Anticipated BCR, depending on future refinement, climate change assumptions, cost contingencies, and benefit aggregation methodology

**~\$50M**

Minimal Tax Base Changes (Buyout)

**MODERATE**

Positive Tax Base Changes (Flood Risk Reduction)

**~95%**

Reduction in impacted wetland, riparian, and upland habitat compared to the prior channel improvement alternative

**~46%**

Reduction in structural flooding along Buffalo Bayou in the 1% AEP Event

**~175**

Limited number of displaced residents (only 25% in EJ areas)

**INCREASED**

Attractiveness for investment and growth



**MINIMAL**

Inducements / impacts to economically disadvantaged populations

**9**

Bridges / evacuation routes prevented from overtopping (0.2% AEP event)

**55%**

Benefits accrued within Econ. Disadvantaged / EJ areas.

**~50%**

Reduction in population at risk in the Buffalo Bayou watershed 1% AEP floodplain

**NO DIRECT IMPACT TO HISTORIC STRUCTURES – LIMITED IMPACT TO POTENTIAL ARCHEOLOGICAL RESOURCES**

**~4**

Only ~4 acres of disturbed habitat suitable for the Alligator Snapping Turtle

**78% / 67% / 51%**

Reduction in habitation loss intensity, habitation loss scale, and habitation loss duration within the Buffalo Bayou Watershed (1% AEP Event)

**63K / 34K / \$4.4B**

Prevents the loss/migration of 63,000 residents and 34,000 jobs, \$4.4B of gross regional product, \$7.8B of total output, and \$3.8B of personal income within Harris and Fort Bend counties.(0.2% AEP Event)

**78K / \$7B / \$6.2B**

Construction expenditures drive GRP increase of \$7.0B, creation of 78,000 jobs, and generation of \$6.2B in labor income.

**~33%**

Reduction in high-risk transportation miles in the Buffalo Bayou watershed (1% AEP event)

**PRESERVATION OF EXISTING PARKS AND REDUCED FREQUENCY AND DURATION OF INUNDATION / RECOVERY**



# Tunnel Performance (Other ACCTS)



**2.2'/3.7'**  
Reduction in 0.2% AEP WSE  
in Addicks / Barker  
Reservoirs

**7-Fold**  
Increase in maximum non-  
damaging release rate  
(2,000 cfs to 14,000 cfs)

**7-Fold**  
Increase in the ability to  
moderate rate of rise  
during a storm event

**7-Fold**  
Decrease in reservoir  
draw-down time from  
GOL (53 days to 7.5 days)

**2-Fold**  
Increase in maximum  
damaging release rate  
(15,000 cfs to 27,000 cfs)

**2% to 0.5%**  
Change in the frequency event at  
which the Addicks emergency  
spillway is engaged

**NEARLY ELIMINATES  
THE ELEVATED RISK  
ASSOCIATED WITH  
SEQUENTIAL EVENTS**

**INCREASED RESILIENCY  
AGAINST CONTINUED  
CLIMATE CHANGE  
(and improved BCR)**

**IMPROVED / ENHANCED  
PERFORMANCE IN LOCALIZED  
RAIN EVENTS**

## REDUCED FREQUENCY OF:

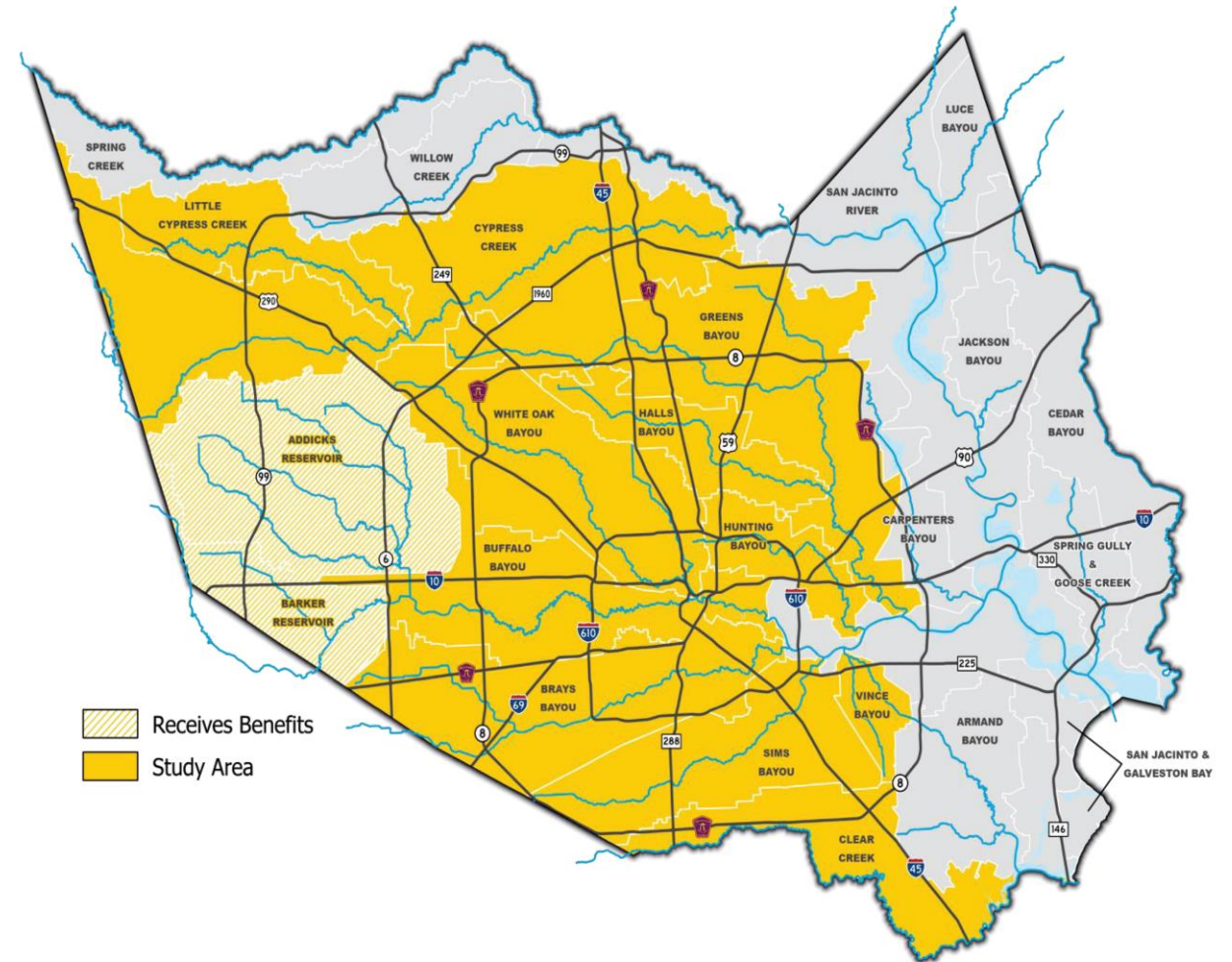
- ✓ GOL EXCEEDANCE
- ✓ DAMAGING RESERVOIR DISCHARGES
- ✓ EMERGENCY SPILLWAY USAGE
- ✓ STRUCTURAL FLOODING (US & DS)

**ACHIEVES FRM OBJECTIVES WHILE  
MINIMIZING NEGATIVE SOCIAL AND  
ENVIRONMENTAL IMPACTS**

- ✓ DOUBLE THE DISCHARGE CAPACITY
- ✓ SECOND CONVEYANCE SYSTEM
- ✓ ADAPTABLE / FLEXIBLE OPERATION

# HCFCFD 203 Study

- June 2023 request submitted to ASA(CW)
- Study area includes:
  - Buffalo Bayou Watershed including Berry, Brays, Greens, Halls, Hunting, Sims, Vince, and White Oak Bayous
  - Clear Creek Watershed
  - Cypress Creek Watershed
- Alternatives will include large-scale tunnel alignments, channelization, stormwater detention basins, nonstructural measures, a combination of these improvements, or no action
- Draw from findings of
  - Phase I and II Tunnel Studies (HCFCFD 2022)
  - Metropolitan Houston Regional Watershed Assessment (USACE 2021)
  - BBTRS (in progress)



“One of the key findings from the 2021 Regional Assessment is that **traditional flood risk management approaches alone will not catch up with flood risk.**”

# What we've found:

- Identified the need for evaluating benefits comprehensively/differently
- Piloted novel approaches to quantifying project benefits in all four accounts
- Preliminary results of distributional analyses show potential for benefits increased by orders of magnitude



# What's Next?

- Other local agencies and states are also researching and piloting new and innovative approaches
- Further benefit methodologies within each USACE account
- Work with USACE to refine ASPs and develop further guidance
- Continued coordination between local agencies and USACE vertical team



# Questions?



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