HARRIS COUNTY FLOOD CONTROL DISTRICT

NWC
Maximizing Comprehensive Benefits – BBTRS Case Study

March 13, 2024

STUDY BACKGROUND

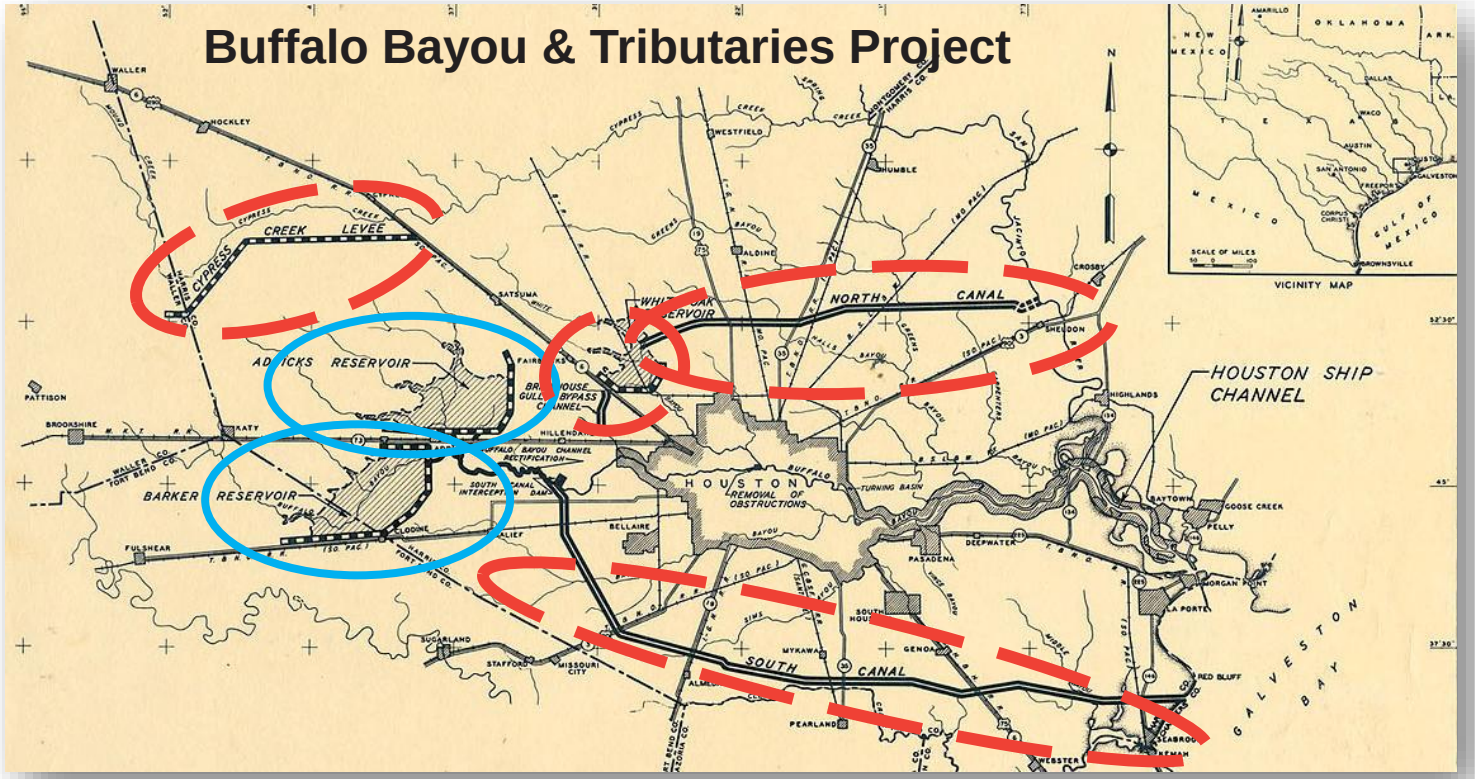
TIMELINE OF EVENTS

Early Flooding: 1929 / 1935

Buffalo Bayou & Tributaries Project

Tax Day Flood (2016)

Hurricane Harvey (2017)



TIMELINE OF EVENTS

Early Flooding: 1929 / 1935

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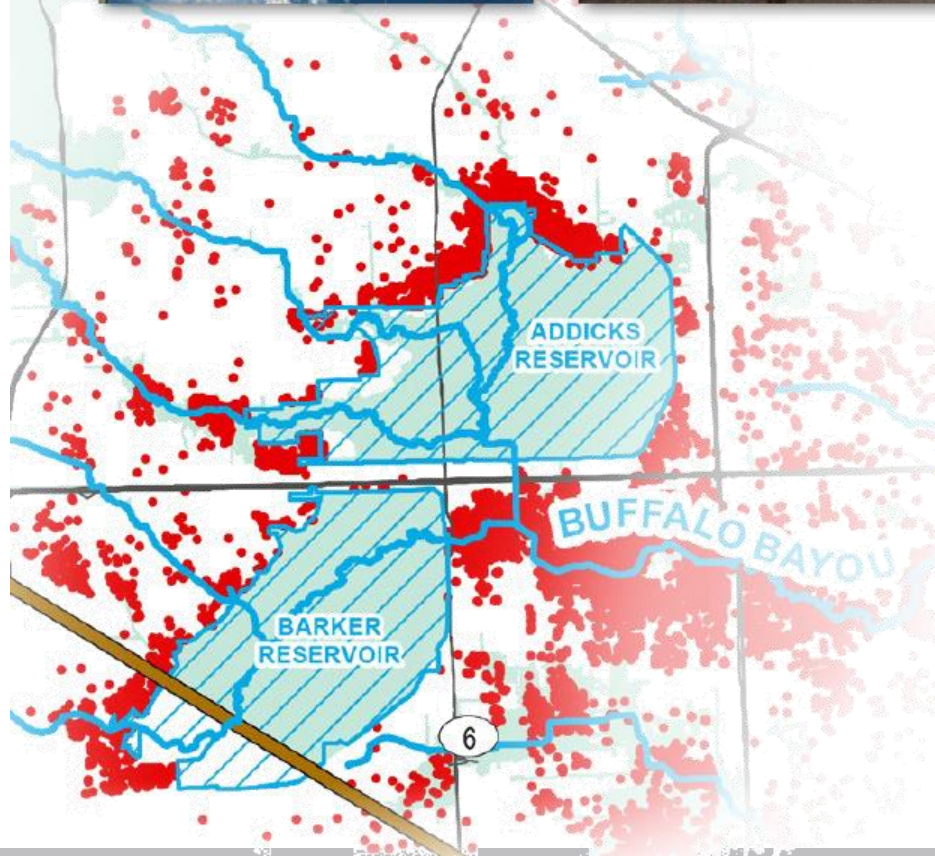

Addicks and Barker Reservoirs During Hurricane Harvey:

25,000 Flooded Structures

15,000 CFS Actual Maximum Release Rate

2,000 CFS Desired Maximum Release Rate

Did You Know?

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

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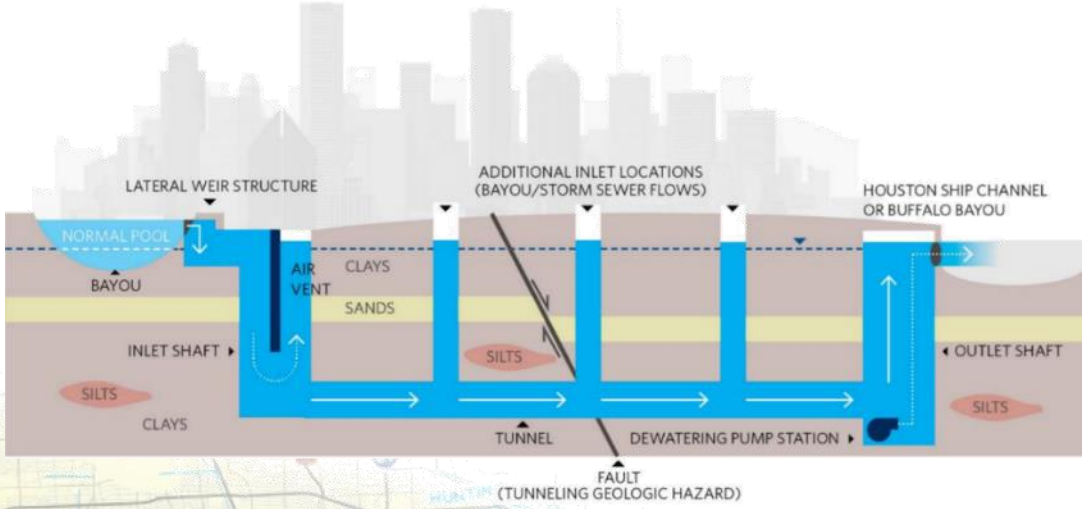
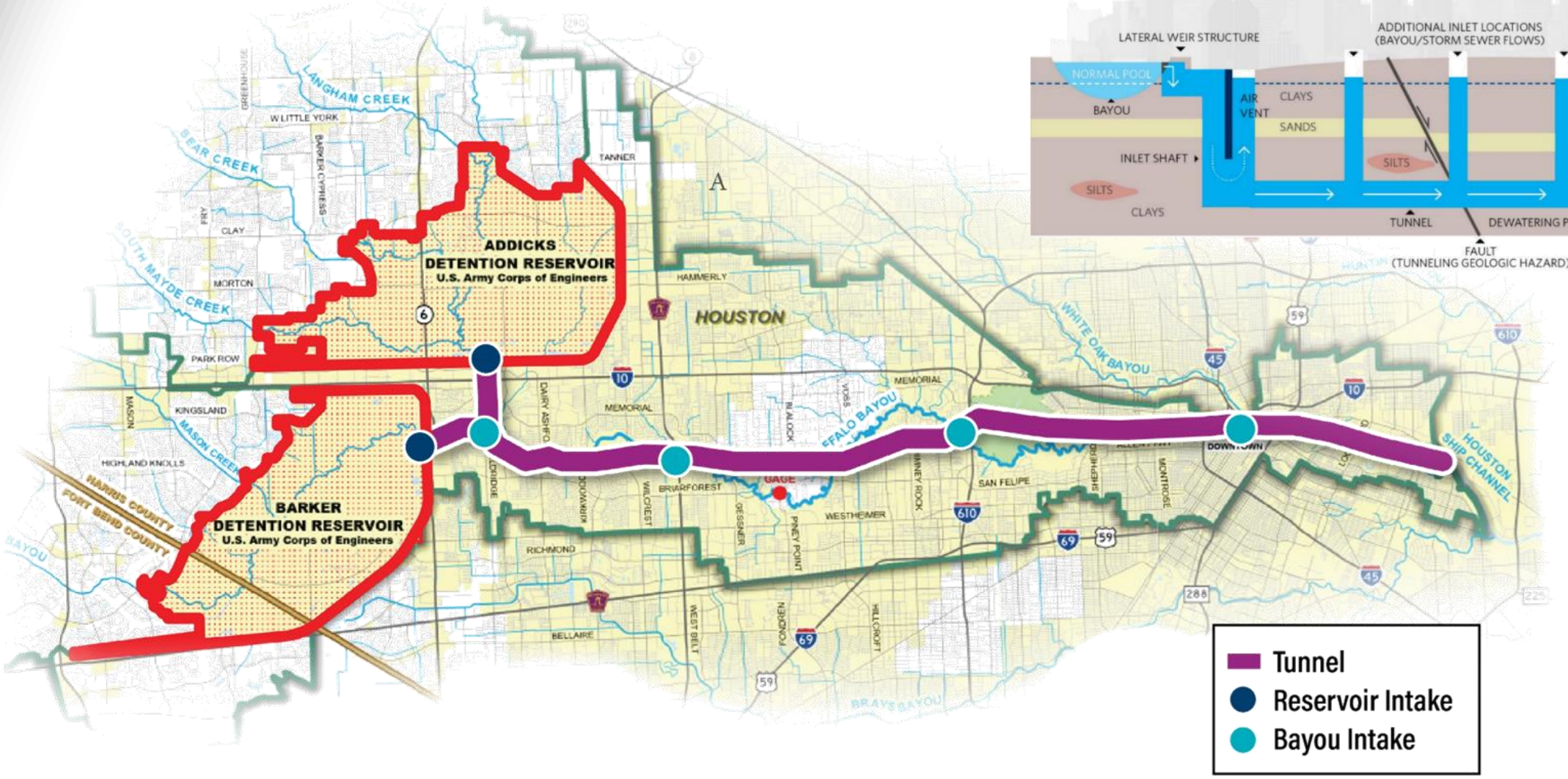
TUNNEL ALTERNATIVE



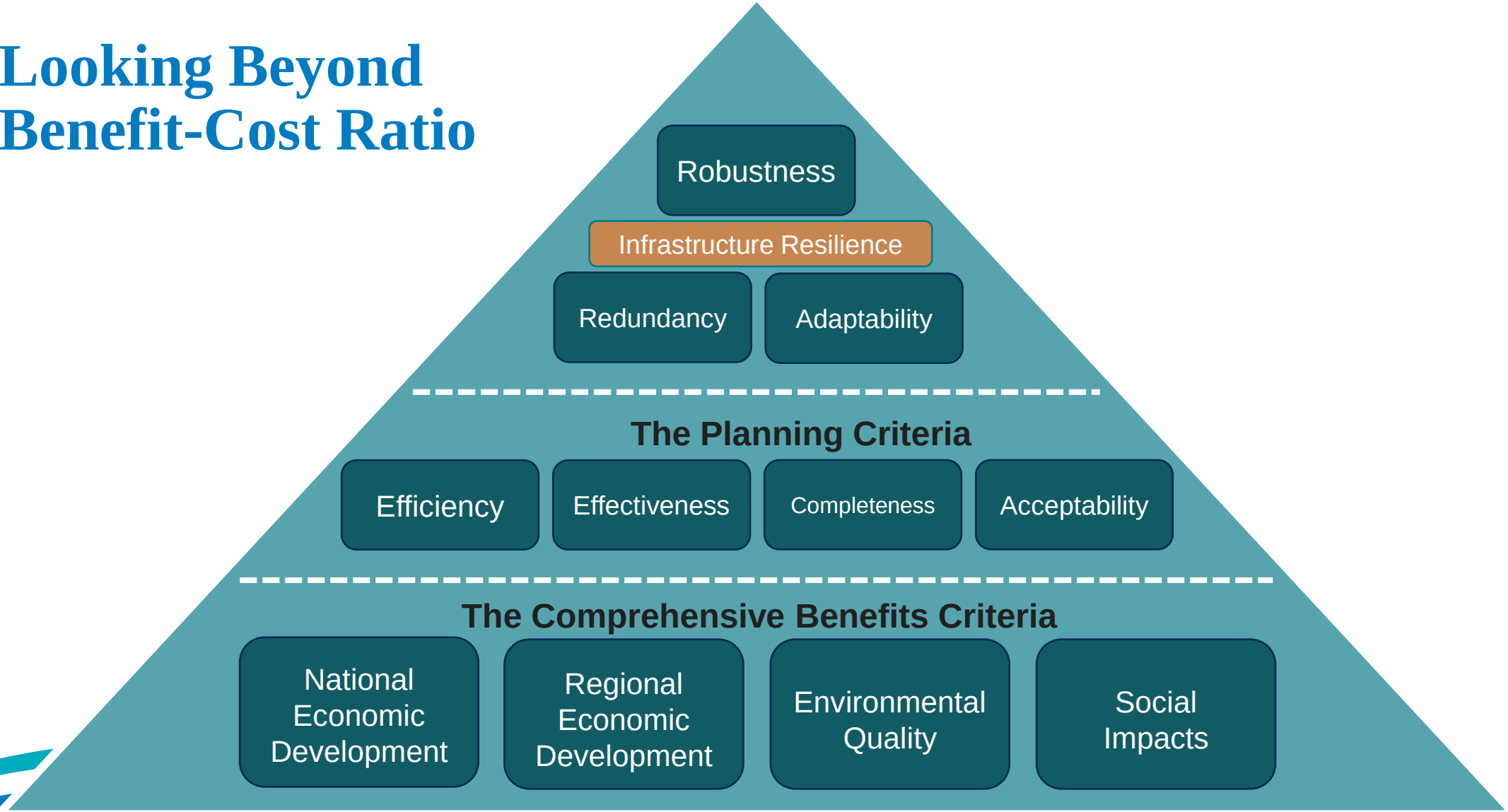


- OVERVIEW -
COMPREHENSIVE BENEFITS ANALYSIS

CBA OBJECTIVES

- Comply with all aspects of the January 2021 “Comprehensive Documentation of Benefits in Decision Document” policy directive
- Provide full and equivalent consideration and accounting of benefits in total and by type, including equal consideration of economic, environmental, and social categories.
- Explain the rationale and basis for the Recommended Plan based on monetary, quantitative, and/or qualitative outputs and Federal, state, and local concerns.
- ‘Focus on the people’ and enhance consideration of the impacts of infrastructure projects and flooding on the strength of our communities and the economy, considering environmental justice and social vulnerability, including compliance with Justice40 Implementation Guidance
- Employ a resiliency framework to better assess the impact of different alternatives on the ability of our infrastructure and communities to withstand, recover, and adapt to disturbances both now and into an uncertain future.
- Identify solutions that align with community and natural values and promote social and economic opportunity.

Looking Beyond Benefit-Cost Ratio



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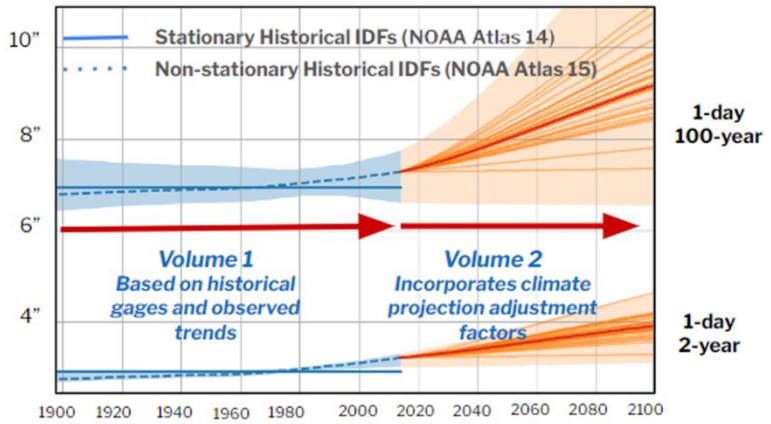
CBA FRAMEWORK / THEMES

ADAPTING TO CHANGING CLIMATE

Previous TP-40 100-yr Rainfall: **13"/24 hours**

New ATLAS 14 100-yr Rainfall: **17"/24 hours** — **30% INCREASE**

NOAA Atlas 15



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.

EFFICIENCY – EFFECTIVENESS – COMPLETENESS – ACCEPTABILITY

REC. PLAN

MAKING IT LOCAL

STATE & LOCAL CONCERNS

EXTENDING OUR UNDERSTANDING

DAM RESILIENCY

OPERATIONAL RESILIENCY

FOUNDATIONAL ELEMENTS

NED ACCOUNT

RED ACCOUNT

OSE ACCOUNT

EQ ACCOUNT

FEDERAL INTEREST JUSTIFICATION

COMPREHENSIVE BENEFITS MATRIX

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.

SEE CHAPTER 6 / ATTACHMENT

Category	Metric	Description	Units	NO ACTION ALTERNATIVE	TUNNEL ALTERNATIVE
NATIONAL ECONOMIC DEVELOPMENT (NED) ACCOUNT					
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	**Addicks:** $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) **Barker:** $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) **Buffalo:** $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) **White Oak:** $81,862,610 EAD $987,345,520 / $2,535,719,410 (1% AEP / 0.2% AEP sing event) 5,316 / 12,894 structures (1% AEP / 0.2% AEP single eve (Assumes 15% increase in future rainfall. Based on Futu Year EAD)	**Addicks:** $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) **Barker:** $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) **Buffalo:** $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)
	Vehicle Damages	Direct vehicle damage for inventory assets	$ - AAE $ - Single Event # - Count	**Addicks:** $15,368,880 EAD $168,386,000 / $927,178,750 (1% AEP / 0.2% AEP sing event) 8,579 / 38,921 vehicles (1% AEP / 0.2% AEP single even **Barker:** $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)	event) 5,101 / 15,651 vehicles (1% AEP / 0.2% AEP single event)

SUMMARY:

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

Bold Charge from HQ:

“Leave no benefits behind”

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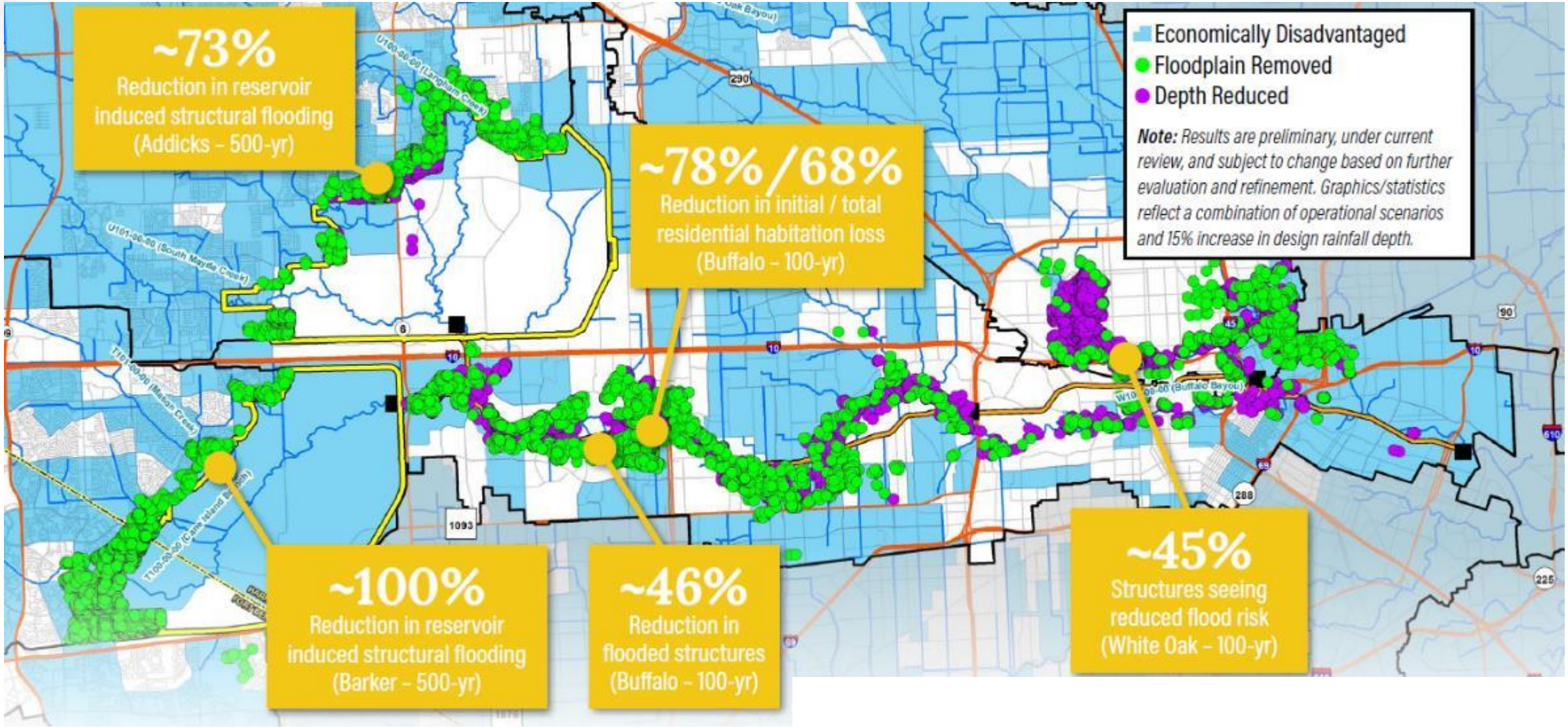
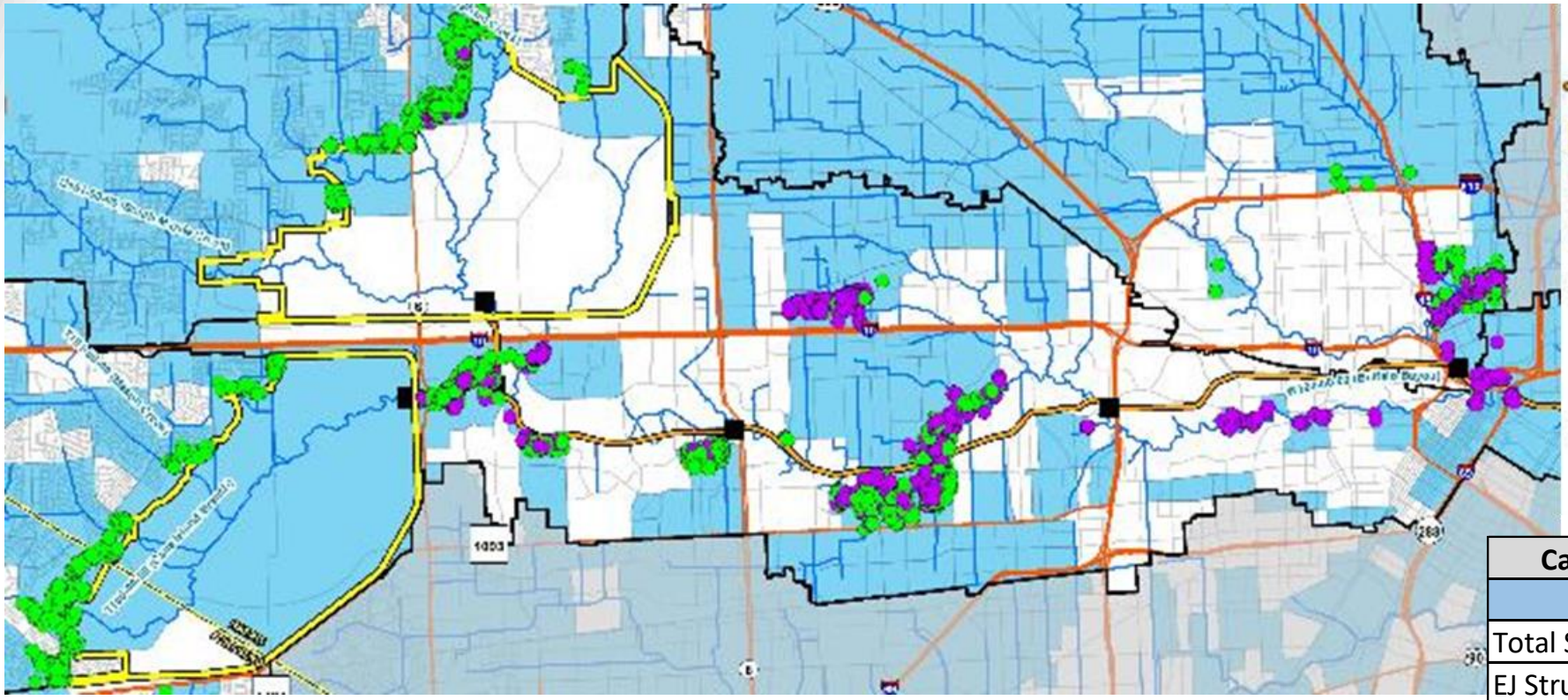
HYDRAULIC RESULTS



JUSTICE 40 - RESULTS



Category	# Flooded	# Removed	# Reduced
W/O FUTURE RAINFALL			
Total Structures	21,879	6,029	4,858
EJ Structures	9,847	2,884	1,625
% EJ Structures	**45%**	**48%**	**33%**
W/ FUTURE RAINFALL			
Total Structures	31,317	9,137	10,675
EJ Structures	15,297	5,021	3,624
% EJ Structures	**49%**	**55%**	**34%**

NOTE: All results are preliminary, under current review, and subject to change based on further evaluation and refinement.
Results presented by Scenario (1, 2, or 3). A&B results quantify changes to reservoir induced flooding outside GOL only, separate from tributary flooding.

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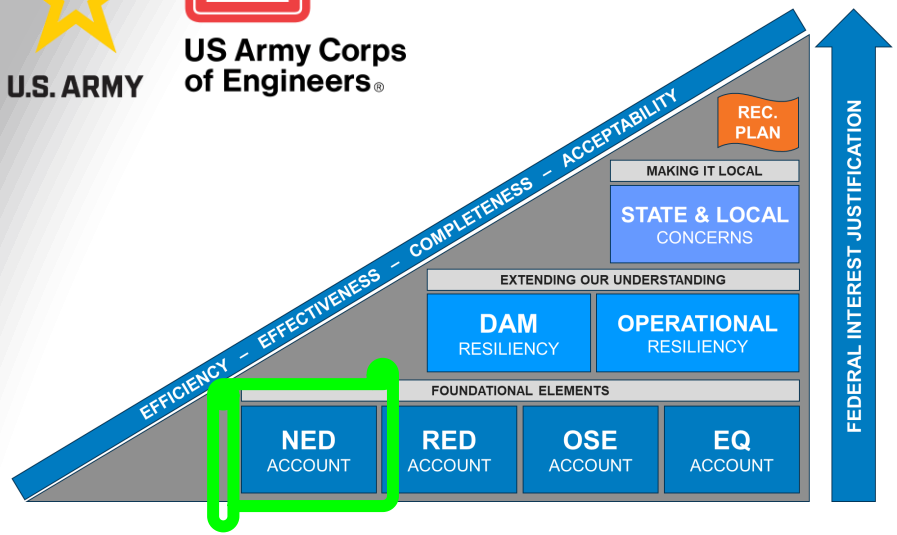
NED ACCOUNT (CH. 7)



$137M+
AAE Benefits
(Scenario 2)

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

~$1B
Land Price Change
A&B Flood Pools

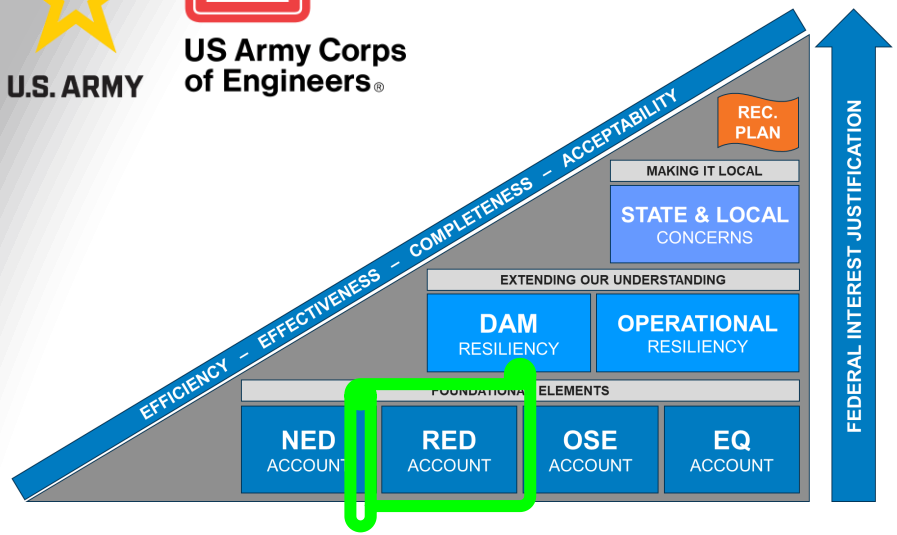
DRIVING METRICS:

- **Flood Damages Reduced:** as reflected in average annual damages avoided, net excess benefits, and benefit-to-cost ratio.
- **Recreational Value Loss:** related to both acquisition/construction impacts to recreation and temporary loss of recreation use as a result of flood events.
- **Land Price Changes:** reflecting the estimated benefit to land value of reduced flood risk, specifically within the reservoir pools of the Addicks and Barker Reservoirs.

SUMMARY TAKEAWAY

Compared conceptually to the other alternatives anticipated to be included in the final array, the Tunnel Alternative is anticipated to be the ***highest performing structural alternative within the NED Account***. Specifically, the Tunnel Alternative is effective at reducing flood damages in the Addicks, Barker, Buffalo Bayou, and White Oak Bayou watersheds, ***generating over $137M of average annual benefits*** (Scenario 2). However, given the generally infrequent nature of flooding and the high cost of construction, the Tunnel Alternative results in a benefit-to-cost ratio of 0.46 (Scenario 2). However, assessment of economic performance is both complex and highly sensitive to future climate conditions. Furthermore, preliminary results represent an un-optimized solution whose ***performance is expected to improve*** as intake configuration/operation is refined in further phases. Regardless, among other alternatives under consideration, the ***targeted flood risk management*** offered by the Tunnel Alternative is anticipated to offer the greatest degree of flood risk reduction and therefore, by extension, NED benefits.

RED ACCOUNT (CH. 8)



DRIVING METRICS:

- **Tax Base Changes (Buyout):** reflecting permanent changes to the number and value of taxable assets (and associated tax revenue) associated with right-of-way acquisition activities.
- **Tax Base Changes (Flood Risk Reduction):** reflecting temporary changes to the value of taxable assets (and associated tax revenue) following a flood event.
- **RED Benefits of Avoided Flood Damages:** reflecting the regional economic benefit (population, employment, output) of reducing flood damages and critical infrastructure impacts.
- **Perception and Attractiveness:** related to the attractiveness of the region for investment and growth, considering both real and perceived flood risk concerns.
- **Economic Impact of Construction Expenditures:** reflecting the impact of construction expenditures on employment, income, value added, and regional output.

~$50M

Minimal Tax Base Changes (Buyout)

MODERATE

Positive Tax Base Changes (Flood Risk Reduction)

RECONS RESULTS

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

REMI RESULTS

(0.2% AEP Event)
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.

INCREASED

Attractiveness for investment and growth

SUMMARY TAKAWAY

Compared conceptually to the other alternatives anticipated to be included in the final array, the Tunnel Alternative is anticipated to be the ***highest performing alternative within the RED Account***. Specifically, the Tunnel Alternative ***minimizes negative RED impacts*** (e.g. removal of tax base) while ***maximizing positive RED benefits*** (e.g., losses avoided by improved flood risk management and investment spurred by reduced real or perceived flood risk). In total, the targeted flood risk management offered by the Tunnel Alternative is anticipated to offer the greatest degree of flood risk reduction and therefore, by extension, ***avoidance of regional economic losses*** (jobs, income, output) in the aftermath of a flood event.

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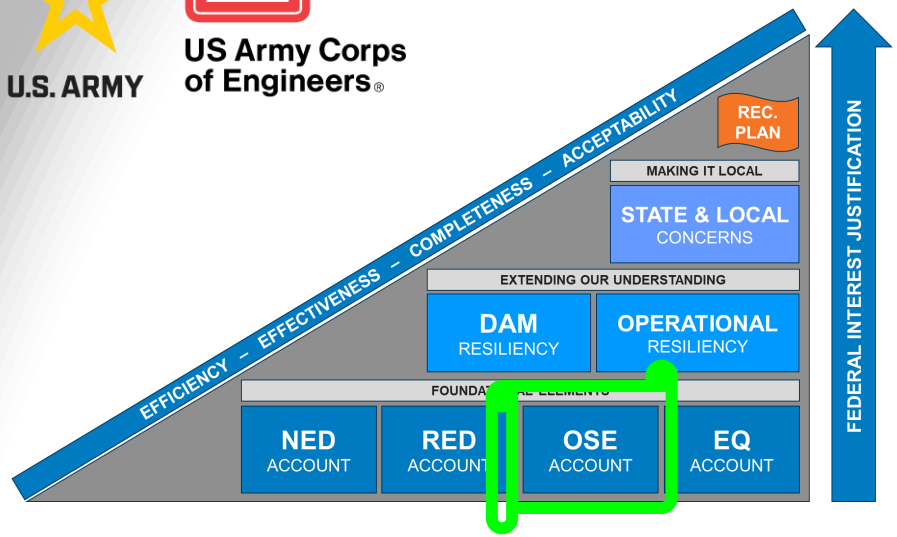
OSE ACCOUNT (CH. 9)



~50%
Reduction in population at risk in the Buffalo Bayou watershed 1% AEP floodplain

~33%
Reduction in high risk transportation miles in the Buffalo Bayou watershed (1% AEP event)

9
Bridges / evacuation routes prevented from overtopping (0.2% AEP event)

~175
Limited number of displaced residents (only 25% in EJ areas)

MINIMAL
Inducements / impacts to economically disadvantaged populations

55%
Benefits accrued within Econ. Disadvantaged / EJ areas.

78.1% / 67.7% / 51.1%
Reduction in habitation loss intensity, habitation loss scale, and habitation loss duration within the Buffalo Bayou Watershed (1% AEP Event)

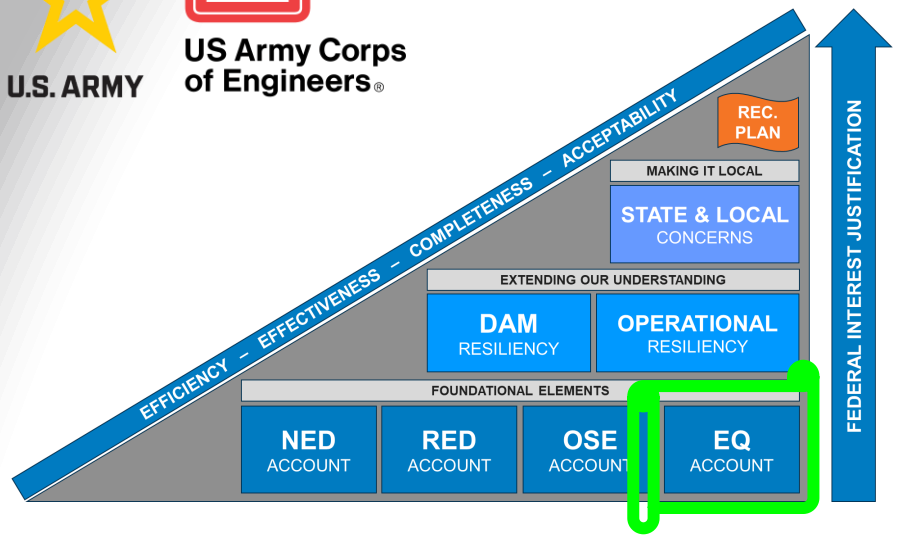
DRIVING METRICS:

- Life Loss Risk / Population 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

SUMMARY TAKEAWAY

Compared conceptually to the other alternatives anticipated to be included in the final array, the Tunnel Alternative is anticipated to be the ***highest performing alternative within the OSE Account***. Specifically, the Tunnel Alternative minimizes negative OSE impacts (e.g., ***displacements, impacts to community character, connectivity, and cohesion***) while maximizing positive OSE benefits (e.g., ***protecting life safety, protecting critical community and environmental resources, reducing residual risk***). Importantly, benefits are generally ***accrued proportionally within environmental justice (vulnerable/disadvantaged) communities***. Of note, the Tunnel Alternative drives significant reduction in habitation impacts, which captures the immediate and persistent social consequences of flooding. Specifically, in the Buffalo Bayou watershed, in the 1% AEP event (Scenario 2), ***initial habitation loss is reduced by 78%, total habitation loss is reduced by 68%, and habitation loss duration is reduced by 51%.*** In total, the targeted flood risk management offered by the tunnel alternative is anticipated to offer the greatest degree of flood risk reduction and therefore, by extension, reduction in the scale and duration of negative social impacts. Accordingly, the Tunnel Alternative ***supports an enhanced level of community resilience***. This includes preserving or enhancing the vibrancy of existing communities, while preparing communities to better withstand and recover faster from both frequent and severe flood events.

EQ ACCOUNT (CH. 10)



~40

Only ~40 Acres of total surface disturbance

~4

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

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

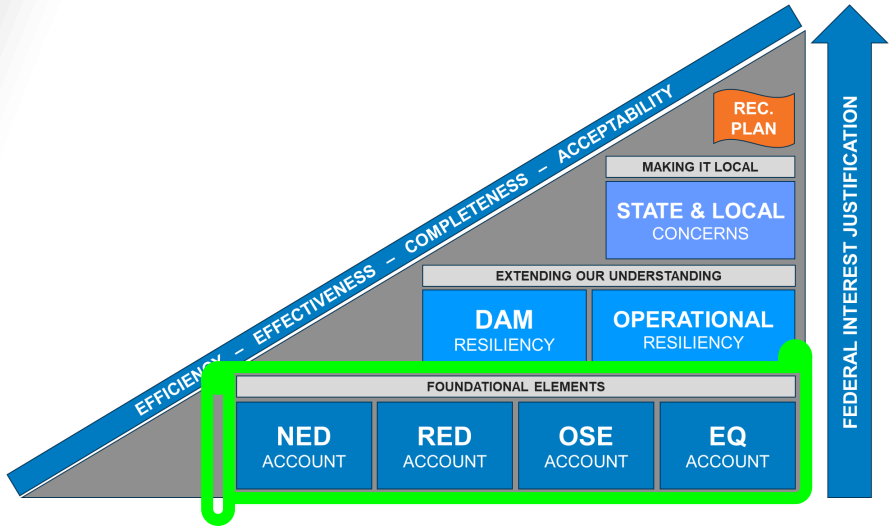
DRIVING METRICS:

- **Footprint / Scale of Disturbance:** reflecting temporary and permanent physical impacts to sensitive habitats or environmental resources.
- **Impact to Threatened and Endangered Species:** reflecting the potential of an alternative to impact threatened and endangered species, considering the number of species and the scale of anticipated impact.
- **Impact to Historic and Archeological Resources:** reflecting the potential of an alternative to impact historic or archeological resources, considering the number of resources and the scale of anticipated impact.

SUMMARY TAKEAWAY

Compared conceptually to the other alternatives anticipated to be included in the final array, the Tunnel Alternative is anticipated to be the ***least environmentally damaging practicable alternative that meets the planning objectives***, with no significant cumulative adverse environmental consequences. Considering the scale of the proposed action ($7B of construction activities) and its broader benefit to the community, the Tunnel Alternative's environmental impacts can be reasonably minimized and is therefore the Tunnel Alternative is anticipated to be the ***highest performing action alternative within the EQ Account***.

FOUR ACCOUNTS SYNTHESIS (CH. 14)



SUMMARY TAKEAWAY

In total, across the Four Accounts, the Tunnel Alternative performs strongly and is anticipated to be the ***highest performing alternative among those ultimately considered***. Importantly, the No Action Alternative does not contribute to any of the planning objectives (e.g. life safety, flood risk reduction, community resilience). Once developed, the Nonstructural Alternative will likely be effective at reducing flood damages in specific locations but will not contribute to the broader infrastructure and community resilience objectives. Furthermore, large-scale buyouts (if identified as the nonstructural alternative) generate significant social consequences that would have to be weighed carefully. Once developed, to produce similar total benefits as the Tunnel Alternative, other structural alternatives would have to demonstrate a similar degree of flood risk reduction, at a similar or lower cost, and without consequential social or environmental effects.

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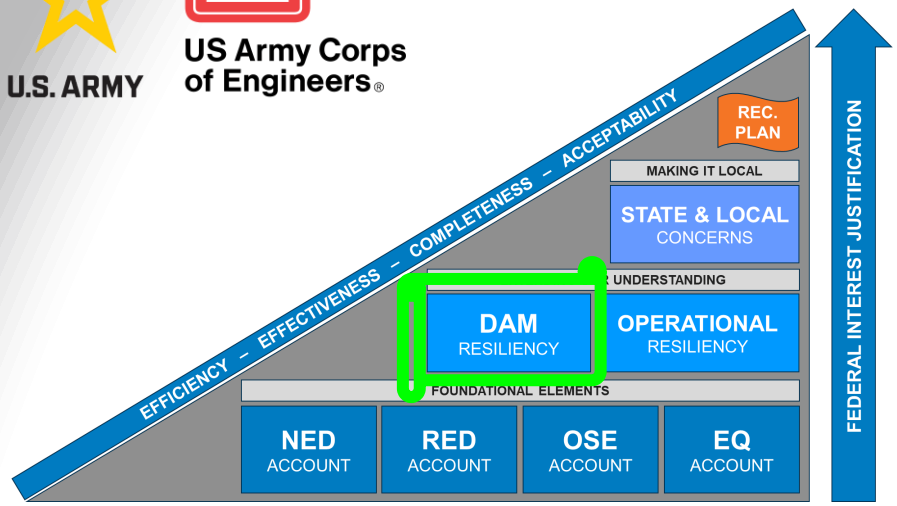
DAM RESILIENCY ACCOUNT (CH. 11)



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

DRIVING METRICS:

- **Reservoir Pool Elevations:** as reflected in peak pool elevations in the 0.2% / 1% AEP flood events, and its implication on risk / dam safety.
- **Maximum Release Rates:** related to the maximum non-damaging release rate and the maximum damaging release rate, and its implication on risk / dam safety.
- **Ratio of Release Rate to Inflows:** related to the ability of reservoir release rates to moderate rate-of-rise within the reservoirs, and its implication on risk / dam safety.
- **Reservoir Drawdown Time:** related to the time required to drain the reservoirs following a flood event, and its implication on risk / dam safety (specifically considering sequential rain events)
- **Frequency of Emergency Spillway Utilization:** related to the frequency of emergency spillway utilization, and its implications on risk / dam safety

SUMMARY TAKEAWAY

Compared conceptually to the other alternatives anticipated to be included in the final array, the Tunnel Alternative is anticipated to be the ***highest performing alternative within the Dam Resiliency Account***. Importantly, the Tunnel Alternative significantly increases the ability of the operator to ***better manage conditions at the reservoir to reduce dam safety risks***, both now and into an uncertain future. Critically, the creation of a secondary conveyance system, with no restrictions on use (see **Section 5.1**), ***maximizes operational flexibility and simplifies reservoir operation***. While not captured in probabilistic flood damages/benefits, reducing (even slightly) the possibility of an adverse dam safety outcome (such as occurred during Hurricane Harvey) has significant flood risk management benefits and ***increases the resiliency of both critical infrastructure and the community at large***.

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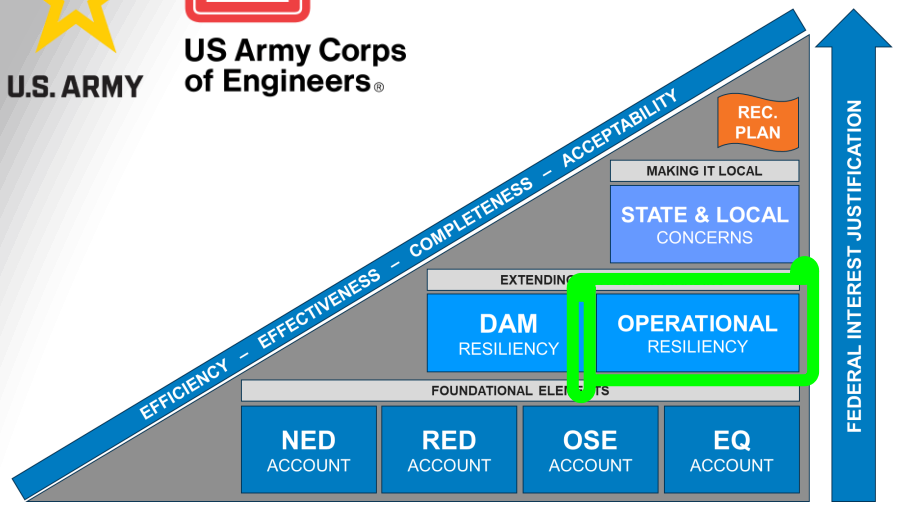
OPERATIONAL RESILIENCY (CH. 12)



DRIVING METRICS:

- **Performance in Back-to-Back Events:** related to the likelihood of sequential rain events causing increased flood damages or further stressing the integrity of the dams.
- **Performance in Geographically Variable Events:** related to the performance of the system under geographically variable rain events
- **Performance in an Uncertain Future:** related to the performance of the system under different climatic conditions, specifically the ability of the system to perform under more frequent and more intense rain events.
- **Operational Robustness:** reflecting the ability of the system to perform under a wide range of conditions, including those different than or worse than the “design” scenario.
- **Operational Redundancy:** reflecting the ability of the system to accommodate maintenance issues or the failure of any single component or combination of components.
- **Operational Adaptability:** reflecting the ability of the system to reasonably adapt to changing needs or conditions
- **Operational Flexibility:** reflecting the ability of the system to tailor operation to target specific concerns or to maximize performance under variable conditions.

NEARLY ELIMINATES THE ELEVATED RISK ASSOCIATED WITH SEQUENTIAL EVENTS

INCREASED RESILIENCY AGAINST CONTINUED CLIMATE CHANGE (and improved BCR)

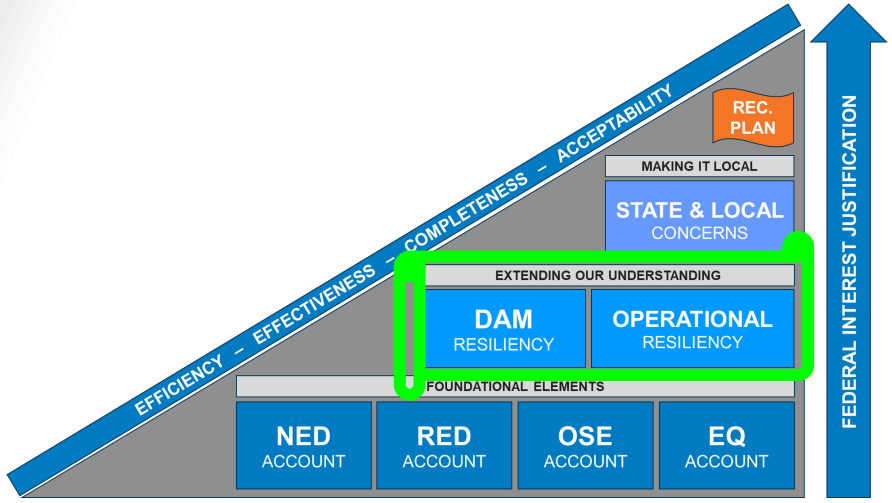
IMPROVED / ENHANCED PERFORMANCE IN LOCALIZED RAIN EVENTS

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

SUMMARY TAKEAWAY

Compared conceptually to the other alternatives anticipated to be included in the final array, the Tunnel Alternative is anticipated to be the ***highest performing alternative within the Operational Resiliency Account***. Importantly, the Tunnel Alternative significantly increases the ability of the operator to better manage the combined system to ***maximize flood risk reduction performance under a wide range of conditions***. While not fully captured in probabilistic flood damages/benefits, the ability to perform under variable conditions drives additional “real-world” economic and social benefits, in addition to ***supporting the resiliency of both critical infrastructure and the community at large***.

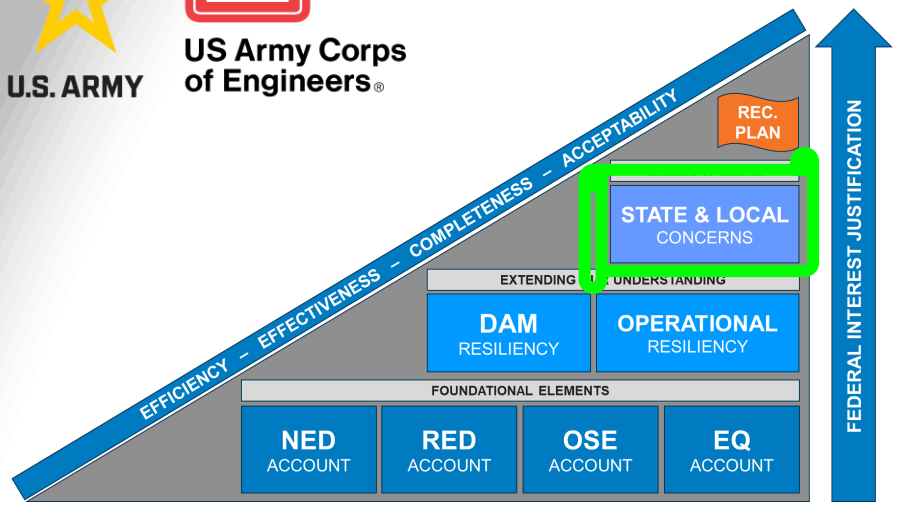
RESILIENCY ACCOUNTS (CH. 14)



SUMMARY TAKEAWAY

In total, across the resiliency accounts, the Tunnel Alternative performs strongly and is anticipated to be the ***highest performing alternative among those ultimately considered***. Importantly, the No Action Alternative does not contribute to any of the planning objectives (e.g. life safety, flood risk reduction, community resilience). Once developed, the Nonstructural Alternative is anticipated to perform poorly within these accounts, as its benefits are anticipated to be isolated only to the properties bought out / floodproofed. As such, there may be little ability to accommodate changing conditions or to contribute to broader resiliency objectives. Once developed, to produce similar total benefits as the Tunnel Alternative, other structural alternatives would have to demonstrate similar contributions to the resiliency and operational flexibility of the dams and the combined regional flood risk management system.

STATE & LOCAL CONCERNS (CH. 13)



REDUCED FREQUNCY OF:

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

ACHEIVES FRM OBJECTIVES WHILE MINIMIZING NEGATIVE SOCIAL AND ENVIRONMENTAL IMPACTS

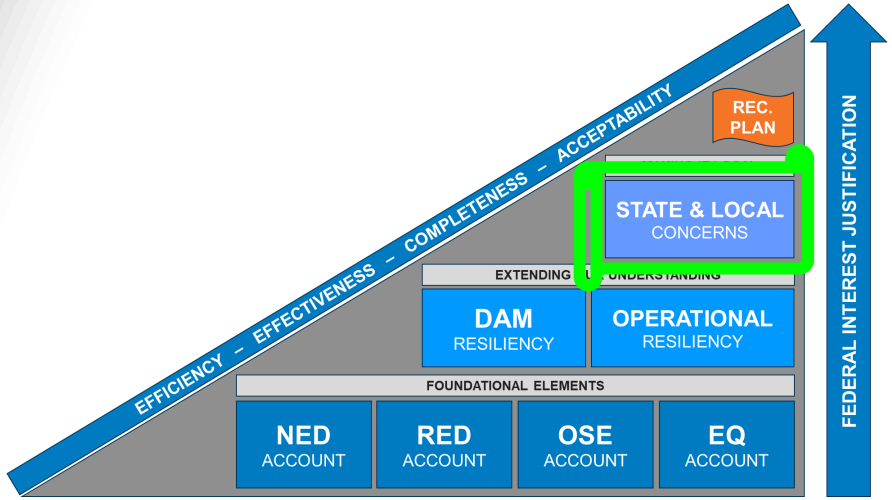
DRIVING METRICS:

- **Frequency of Adverse Outcomes:** including 1) the frequency event at which emergency spillways are engaged, 2) the frequency event at which reservoir pool elevations exceed the limits of government owned land, 3) the frequency event at which structures start to flood upstream of the Addicks and Barker Reservoirs, 4) the frequency event at which nondamaging discharges to Buffalo Bayou are triggered, 5) the frequency event at which damaging discharges to Buffalo Bayou are triggered, and 6) the frequency event at which discharges cause structural flooding on Buffalo Bayou.
- **Responsiveness to State and Local Concerns:** related to the ability of an alternative to address State and local concerns, as documented throughout the study process.
- **General Acceptability of the Proposed Action:** related to the ability of an alternative to address community expectations and issues of primary concern.

SUMMARY TAKEAWAY:

State and Local Concerns Account: Compared conceptually to the other alternatives anticipated to be included in the final array, the Tunnel Alternative is anticipated to be the ***highest performing alternative within the State and Local Concerns Account***. Importantly, the Tunnel Alternative ***reduces the frequency and severity of adverse outcomes associated with the operation of the Addicks and Barker Reservoirs*** to a level commensurate with public expectations. Furthermore, the Tunnel Alternative achieves this desired level of flood risk reduction while ***minimizing community and environmental impacts***. State and local concerns do not want the “cure” to be more detrimental than the “disease” and aim to prevent the inequitable distribution of negative project impacts to marginalized or vulnerable populations. The Tunnel Alternative ***successfully addresses stated state and local concerns***. As a result, the general public would strongly support the Tunnel Alternative.

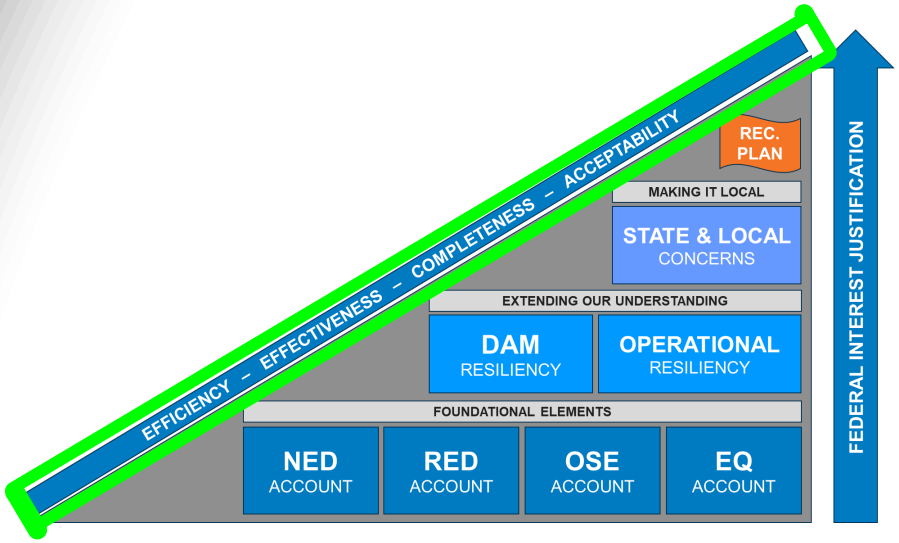
STATE & LOCAL CONCERNS (CH. 14)



SUMMARY TAKEAWAY

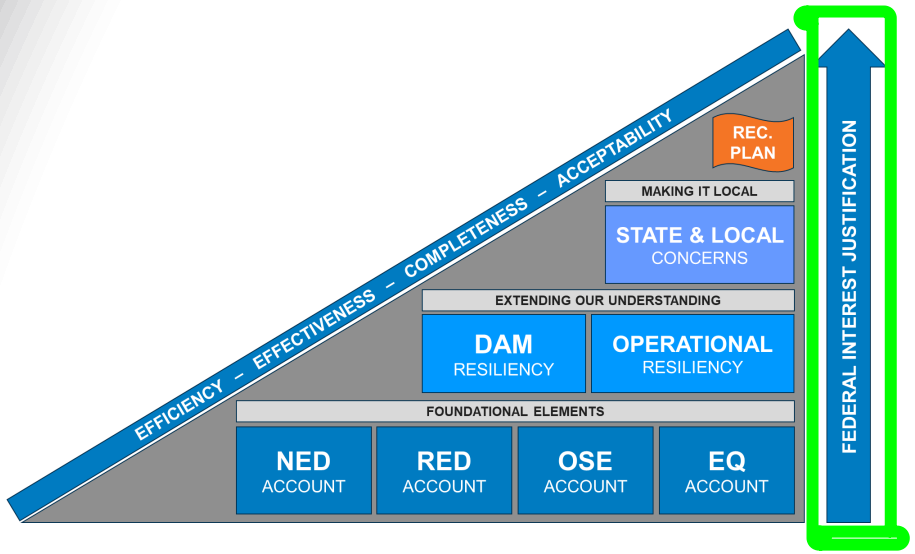
Within this account, the Tunnel Alternative performs strongly and is anticipated to be the ***highest performing alternative among those ultimately considered***. Importantly, the No Action Alternative does not contribute to any of the planning objectives (e.g. life safety, flood risk reduction, community resilience). Furthermore, due to climate change, ***inaction will only lead to an increase in the frequency and severity of adverse outcomes*** associated with the Addicks and Barker Reservoirs. Accordingly, there would be no state or local support for a "No Action" recommendation. Once developed, the Nonstructural Alternative may struggle to balance flood damage reduction with State and local concerns related to environmental justice and community integrity. Once developed, to produce similar total benefits as the Tunnel Alternative, other structural alternatives would have to demonstrate a similar degree of flood risk reduction without inducing adverse consequential social or environmental impacts.

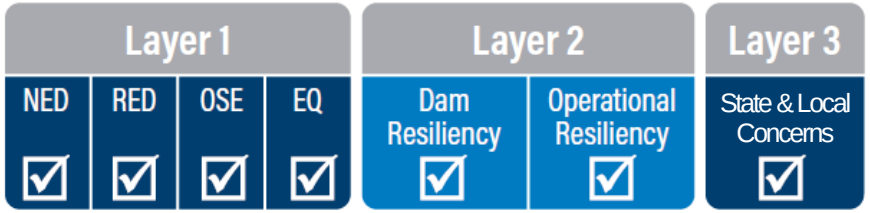
PLANNING CRITERIA (CH. 14)



- **Effectiveness:** The Tunnel Alternative is effective at reducing life safety risks and flood damages while promoting community resilience. This is demonstrated by the scale of improvements (e.g. 73 / 100% reduction in reservoir induced flooding upstream of the Addicks / Barker Reservoirs [0.2% AEP, Scenario 1, with future rainfall], 46% reduction in flood structures in the Buffalo Bayou watershed [1% AEP, Scenario 2, with future rainfall]. This includes consideration of future climate change, providing increased resiliency into an uncertain future. Further optimization of the tunnel intake structures is expected to increase the effectiveness of this alternative.
- **Efficiency:** The Tunnel Alternative, measured exclusively within the NED Account, has not yet been shown to be efficient / cost-effective, as reflected by a benefit-to-cost ratio below unity. However, performance is anticipated to continue to improve as engineering refinement is performed, and benefits are further quantified across the full range of operational scenarios. Furthermore, when including both monetary and non-monetary RED and OSE benefits, contributions to community resiliency are significant and may substantiate Federal interest in the proposed action.
- **Completeness:** The Tunnel Alternative represents a complete solution, not requiring additional improvements to achieve the benefits projected. Importantly, this includes consideration of future climate change, supporting desired performance over the analysis period (50 years) and the anticipated project lifespan (100 years).
- **Acceptability:** The Tunnel Alternative complies with applicable laws, regulations, and public policies. Specifically, this includes compliance with local floodplain management standards. In addition, the alternative represents what is anticipated to be the least environmentally damaging practicable alternative. Furthermore, the Tunnel Alternative has broad-based support from State and local concerns.

TOTAL BENEFITS (CH. 14)



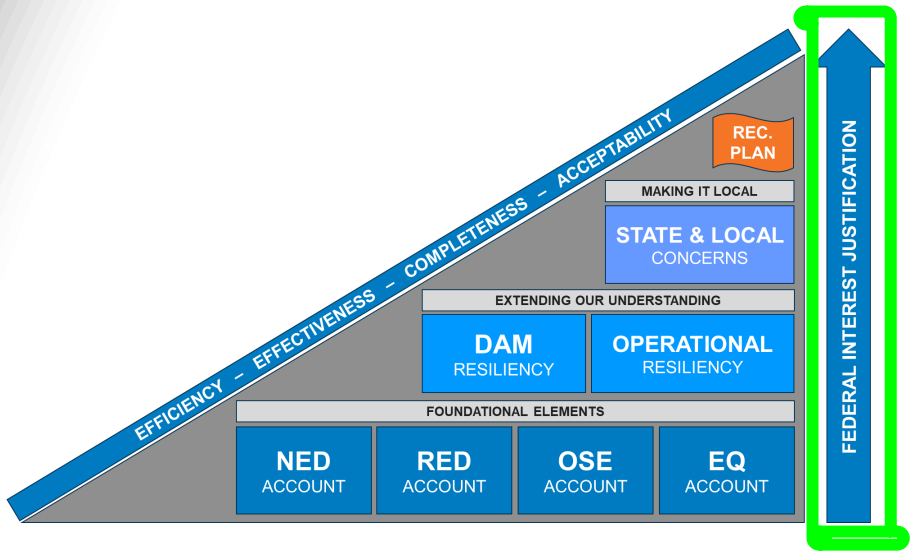


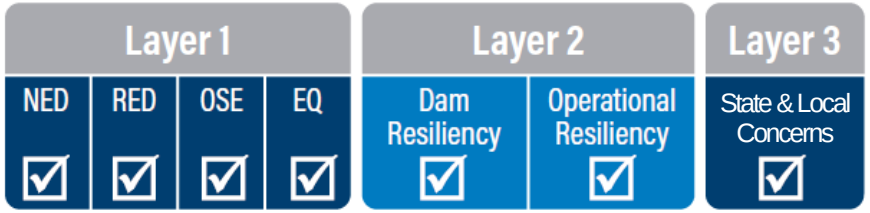
ANTICIPATED TOP PERFORMER

SUMMARY TAKEWAY

The Tunnel Alternative consistently shows strong performance across a wide variety of metrics and is anticipated to be the ***highest performing alternative within each of the Four Accounts and across all three layers of evaluation***. The total benefits of the Tunnel Alternative are reflected in reduced flood damages, reduced life safety risks, reduction in adverse economic, social, and environmental impacts of the proposed action, significant improvements to the resiliency of the regional flood risk management system in the face of changing climate, the vitality of at-risk neighborhoods, and the ability of communities to better withstand and recover from severe flooding events. Furthermore, the flexible operation of the tunnel system allows for an operational strategy that can maximize performance in any given flood event and can be tailored to offer flood risk reduction to those most vulnerable. No other alternative is anticipated to produce the benefits of the flexible Tunnel Alternative while minimizing adverse impacts across the full spectrum of accounts.

TOTAL BENEFITS (CH. 14)





ANTICIPATED TOP PERFORMER

ADDITIONAL KEY TAKEAWAYS:

The Tunnel Alternative ***effectively addresses study objectives*** (flood risk reduction, dam safety, and community resiliency) with ***minimal environmental and social impact***, in accordance with state and local input. As such, benefitted communities are strengthened by the proposed Federal action, not impaired, which enhances the ability of at-risk communities to better withstand and recover from severe flood events. The Tunnel Alternative empowers resilient communities through innovative flood risk management.

By incorporating risk and uncertainty associated with climate change into the planning process, the Tunnel Alternative is able to ***address not only the challenges of "today" but also the risks of "tomorrow"***. Critically, the region must prepare for more frequent and intense rain events. The Tunnel Alternative represents a robust climate adaptation strategy.

DISCUSSION