Progress on the Investigation of Large-Diameter Stormwater Tunnels

What we know, and where we are going.

Greater Houston Port Bureau
February 9, 2023

HARRIS COUNTY FLOOD CONTROL DISTRICT

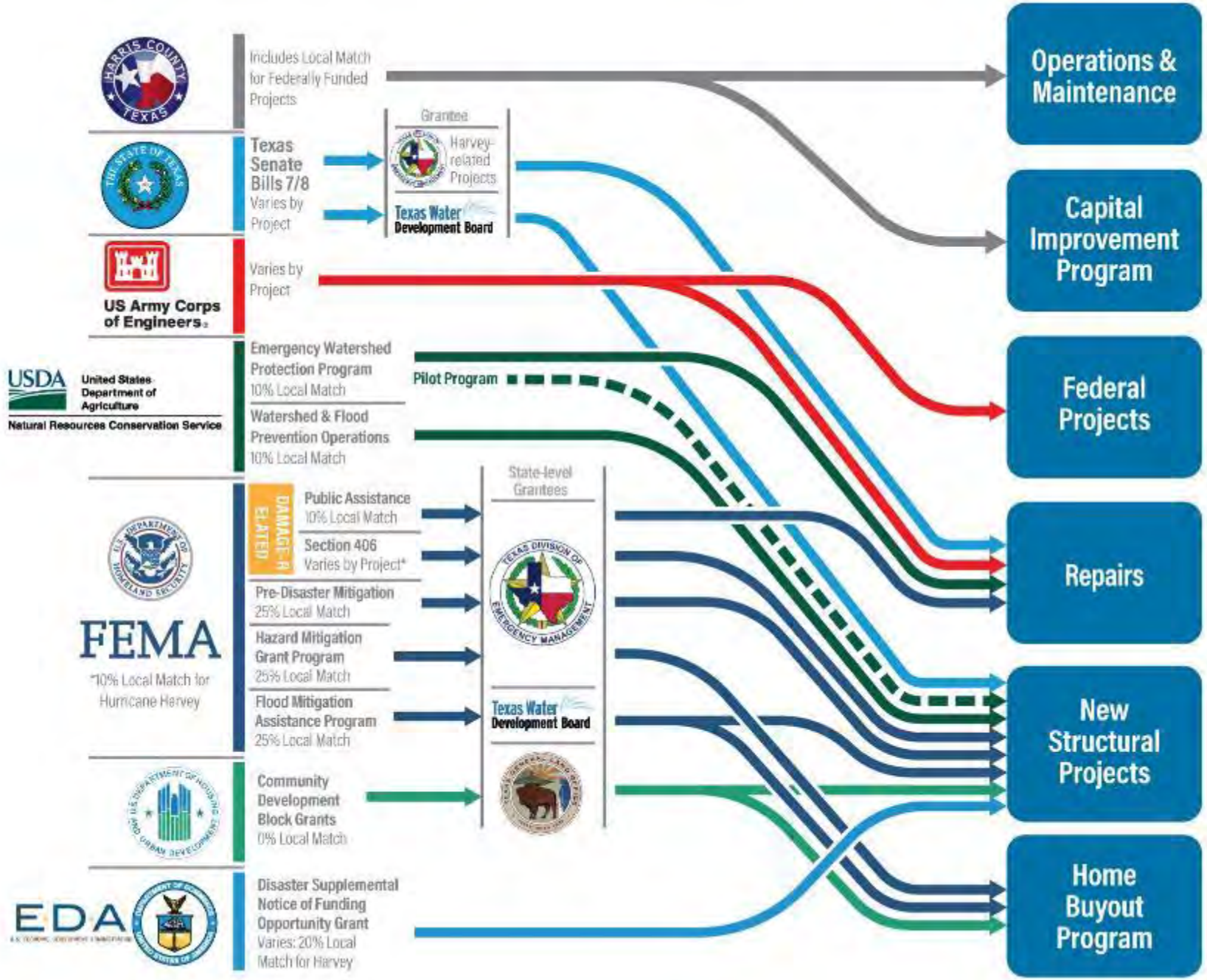
Feasibility Study of Stormwater Conveyance Tunnels

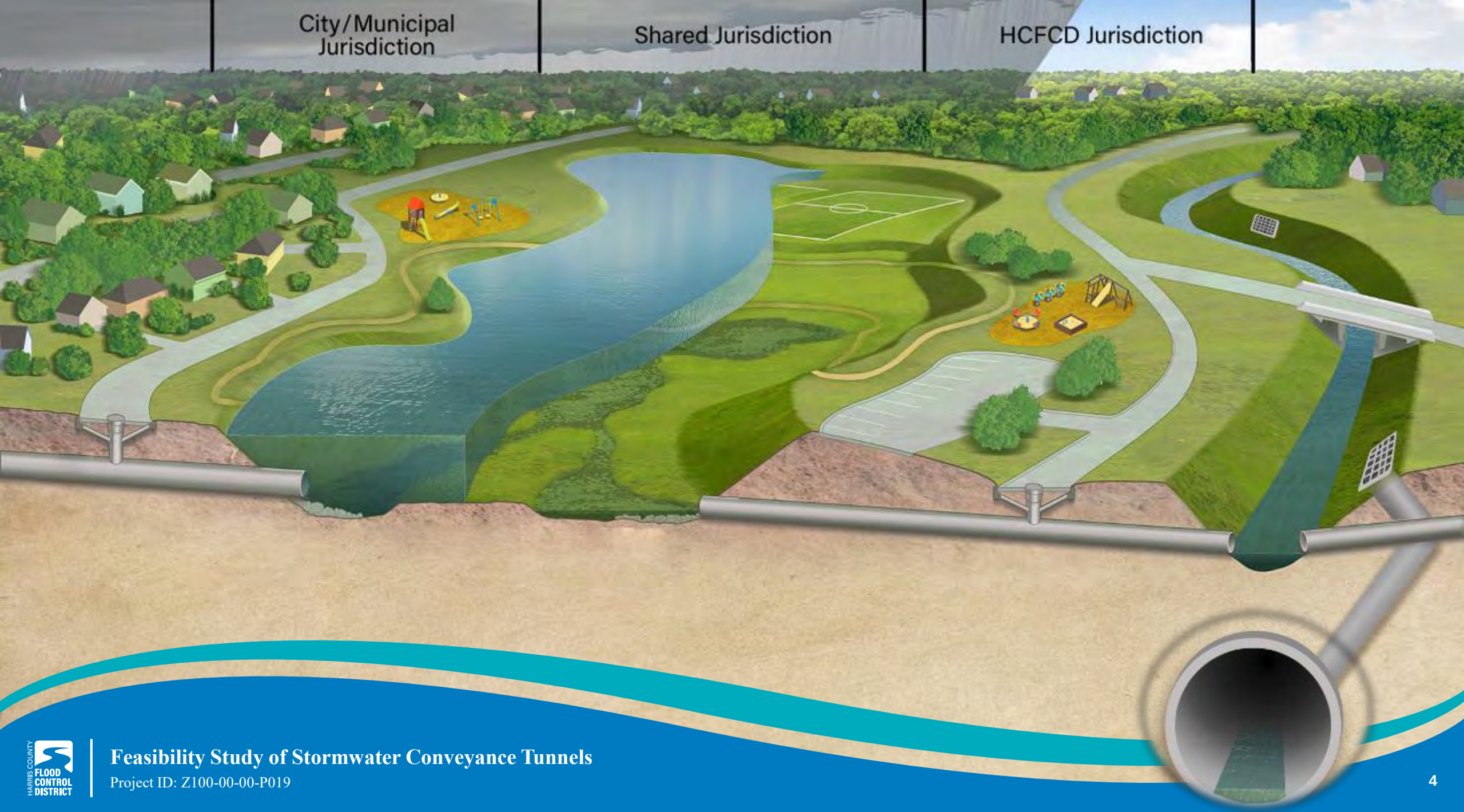
Project ID: Z100-00-00-P019

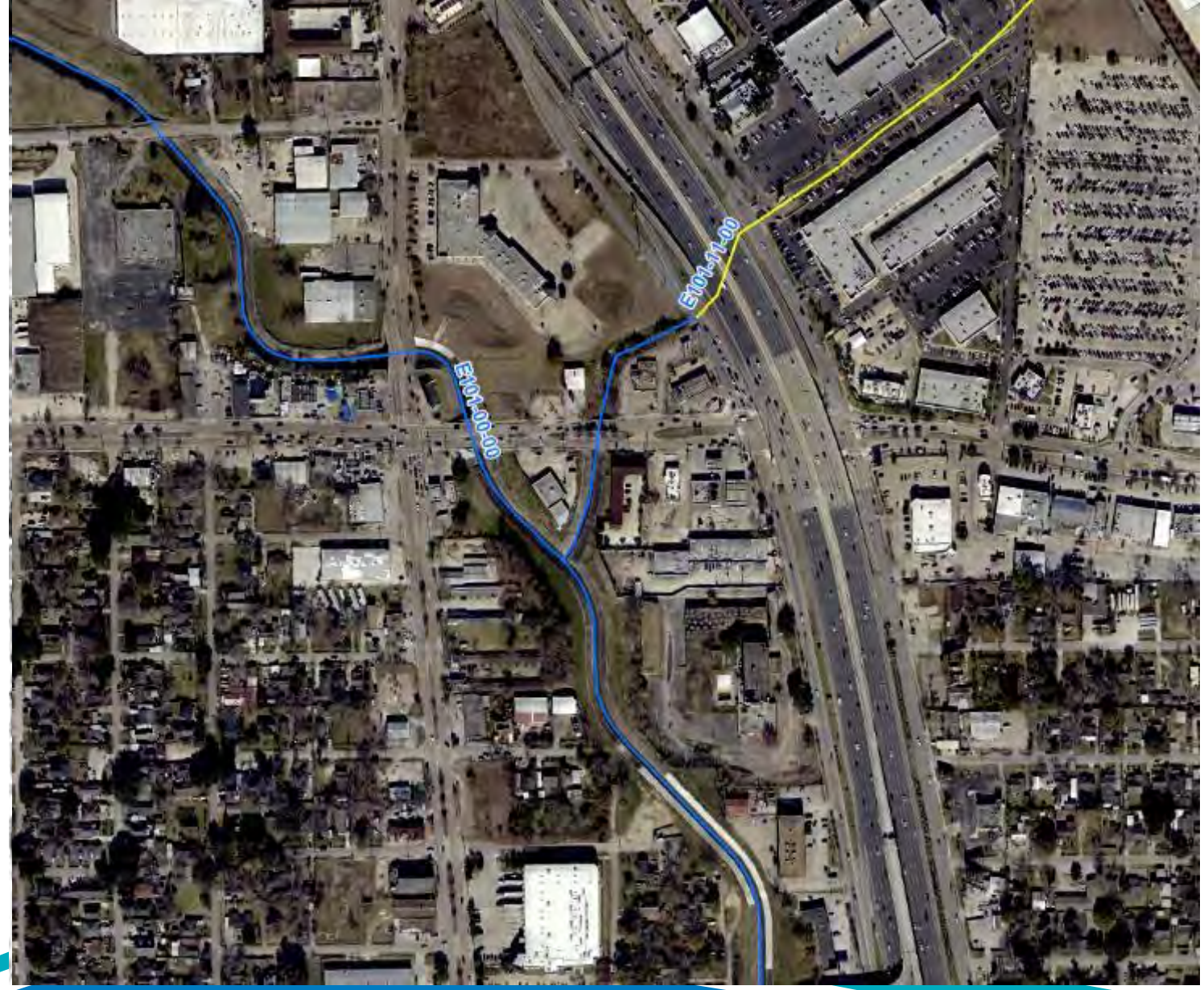
Our Mission

Provide flood damage reduction projects that work, with appropriate regard for community and natural values.

How is HARRIS COUNTY FLOOD CONTROL DISTRICT funded for disaster recovery & resiliency?




City/Municipal Jurisdiction
Shared Jurisdiction
HCFCD Jurisdiction



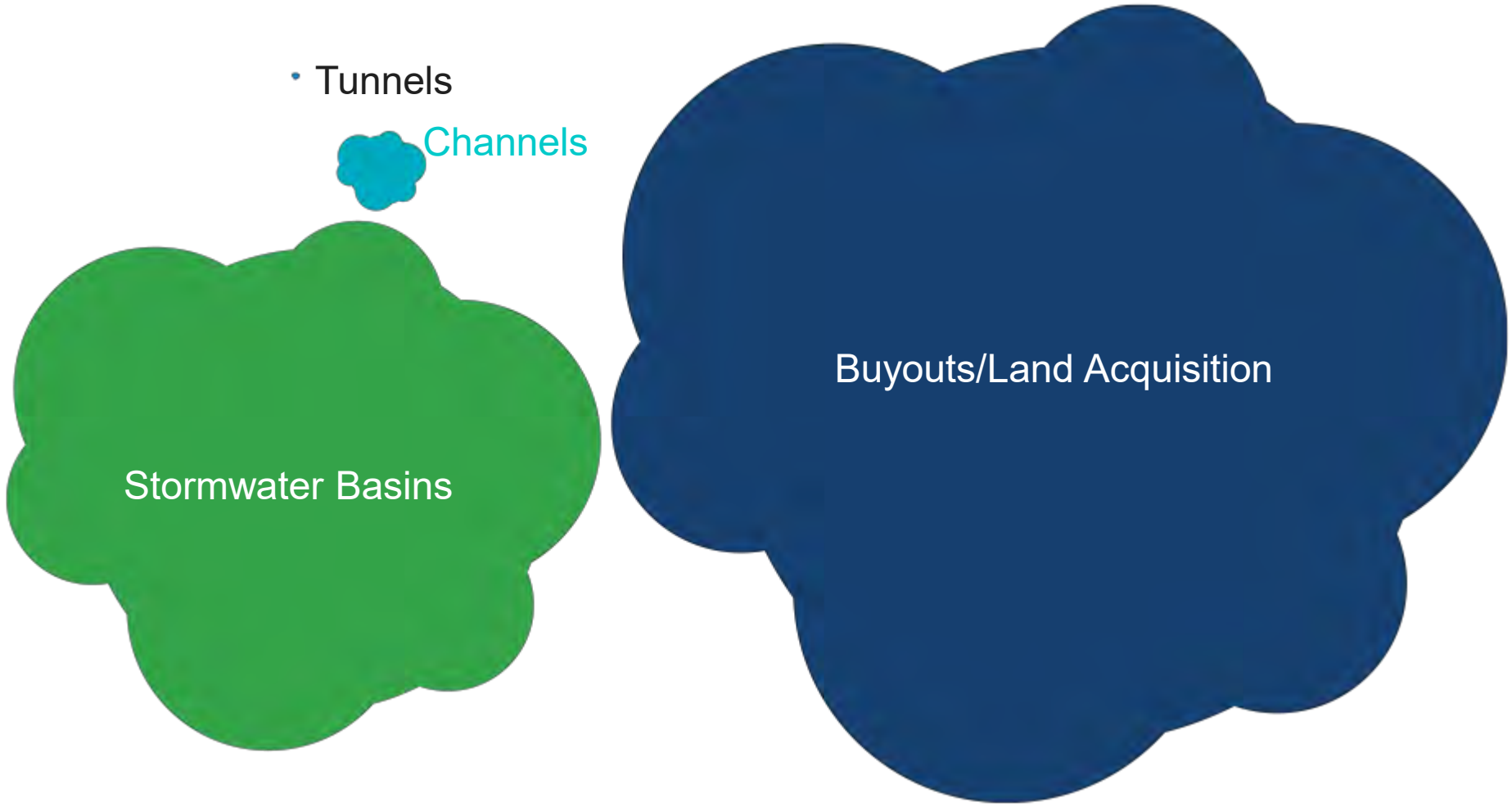
Population Density

Development makes it more challenging to construct traditional options like channels and basins

- 1930
- 1953
- 2021

Channel Expansion Challenges

- Less available land in certain areas
- Residential property acquisition is required more and more often
- Environmental impacts
- Adverse impacts require additional land for mitigation

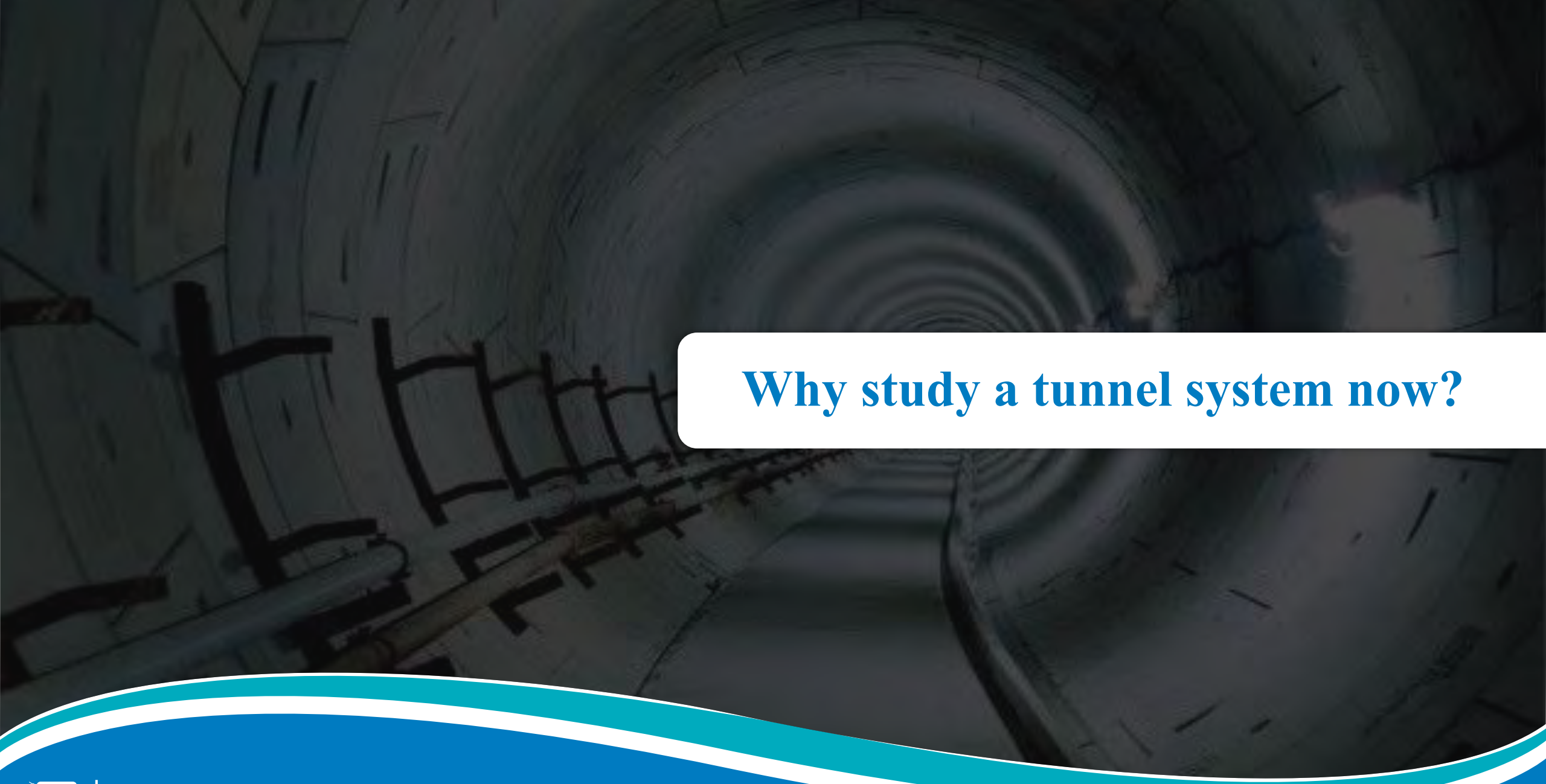


How much surface land?

- 34 acres: Tunnels
- 377 acres: Channel Improvements
- 1,882 acres: Stormwater Basins*
- 3,145 acres: Buyouts/Land Acquisition

Shown for Representational Purposes Only

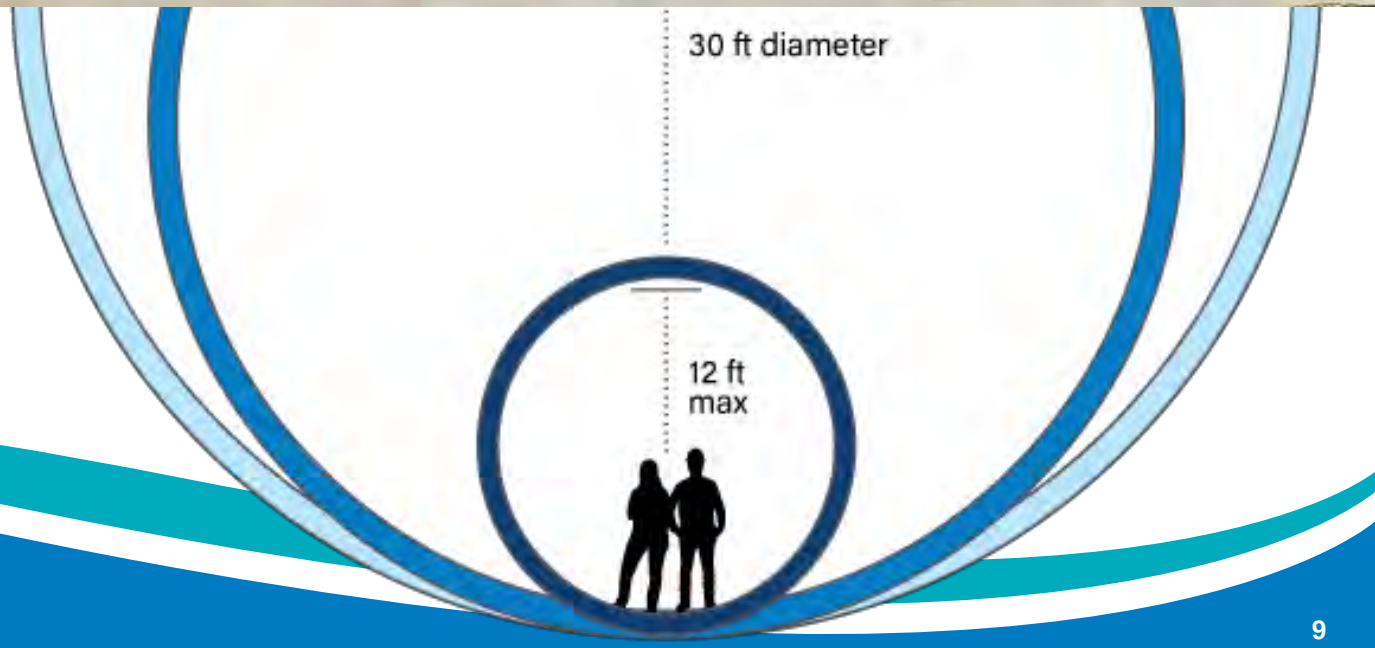
* A combination of these tools are typically required (versus the single tool)



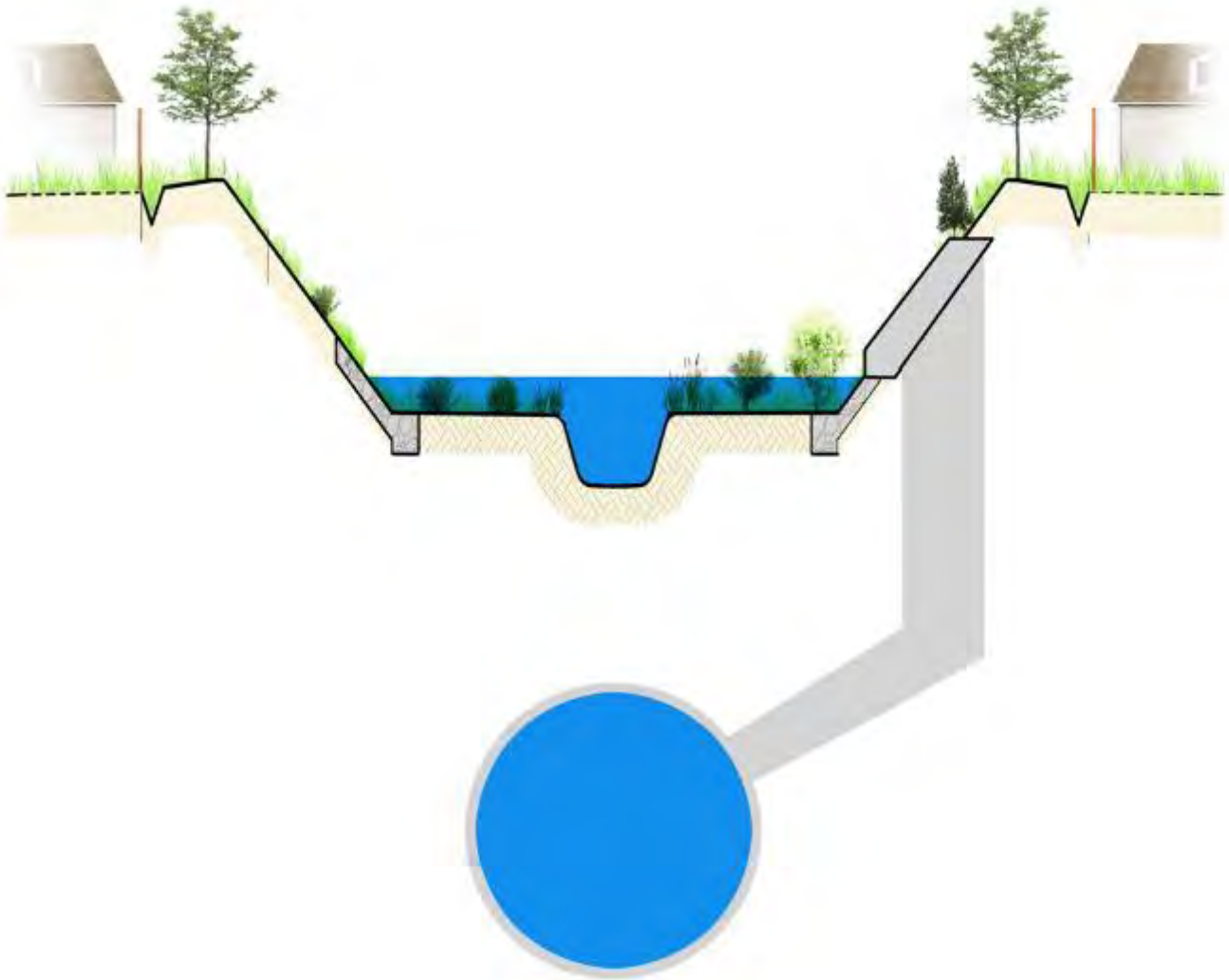
Why study a tunnel system now?

How Different is a Stormwater Tunnel?

- 30 to 45 feet in diameter
- 9-25 miles in length
- Tunnel is 80 to 100 feet underground
- Tunnels carry exponentially more water than a storm sewer



How Different is a Stormwater Tunnel?

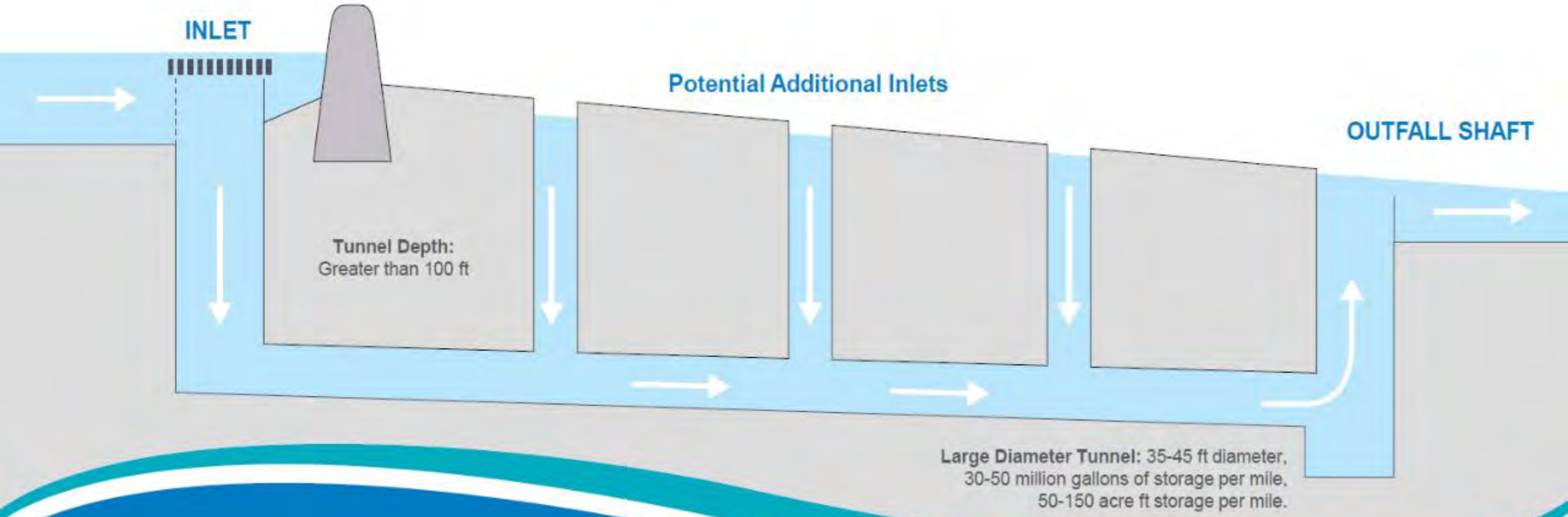


Tunnels and channels work together

- In heavy rain as a channel fills, water drains into the tunnel inlets
- Several inlets to each tunnel
- Water moves downstream to a strategically placed outlet

How Does a Stormwater Tunnel Work?

Gravity Moves the Water



So, what do we know so far?

Tunnel Outfall System

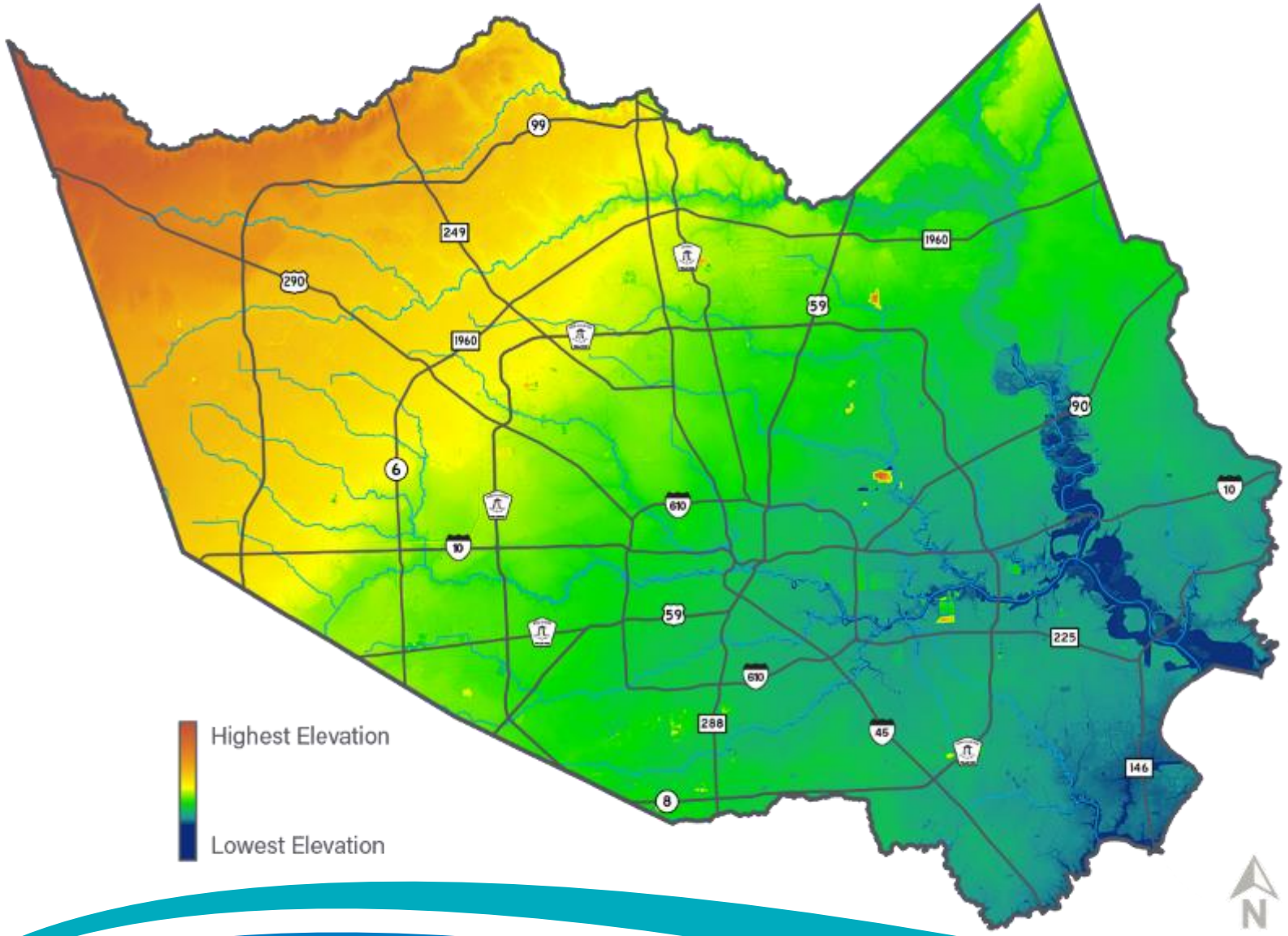
What it Looks Like: San Antonio Flood Control Tunnel Outfall

Tunnel Study Phase 1: Feasibility
Go/No-Go

Critical Factors

- Can we build tunnels in our geological conditions?
- Can tunnels move enough water to make a difference?

For information on Phase 1 please visit: **https://www.hcfcd.org/Z-08**



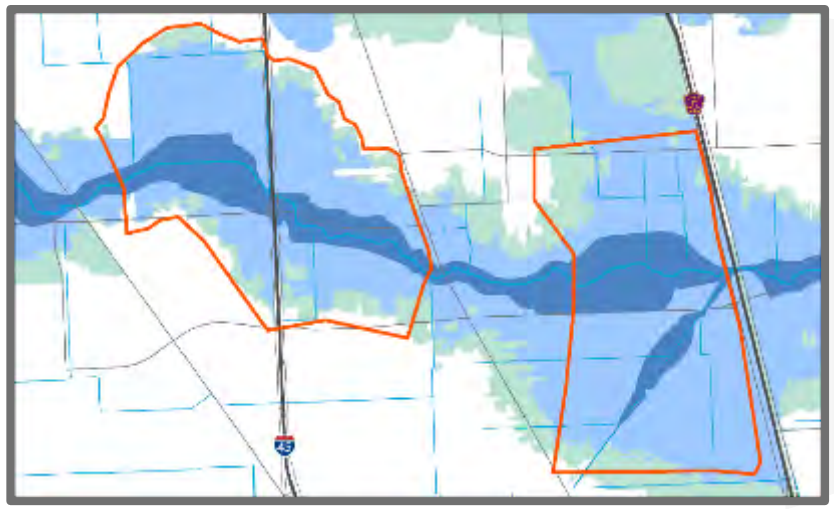
Tunnels Operate Using Gravity

There is a 244’ elevation change across Harris County.

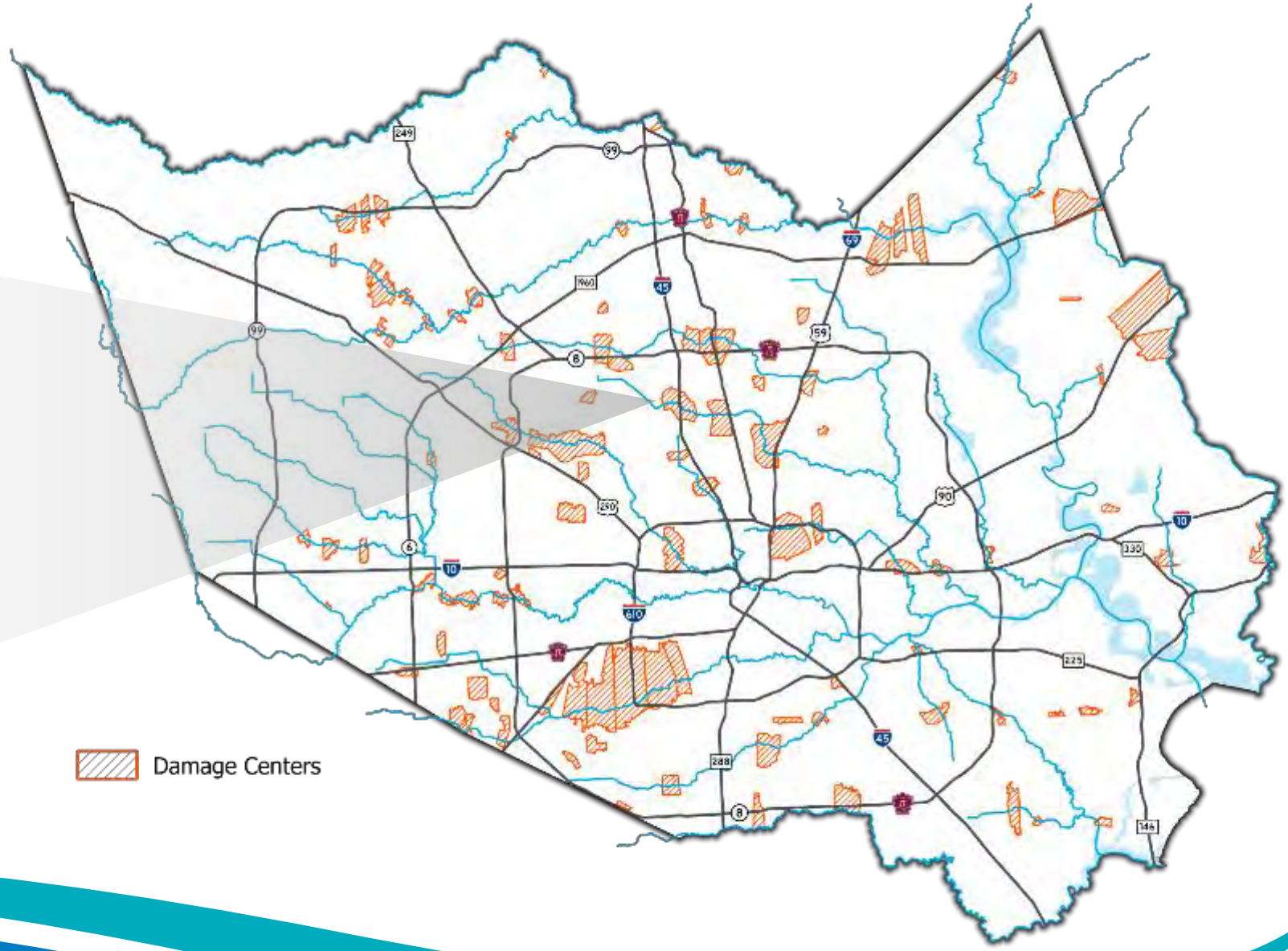
Tunnel Study Phase 2: Feasibility

- **Step 1: Evaluate all 23 Watersheds**
- **Step 2: Identify criteria**
  - —Sufficient elevation
  - —Population density
  - —High risk flood damage centers
  - —Social Vulnerability
  - —Life Safety
  - —Geologic and man-made hazards
  - —No downstream impacts
  - —Tidal Influence
- **Step 3: Identify 11 watersheds where tunnels would likely be most effective and beneficial**

Damage Centers



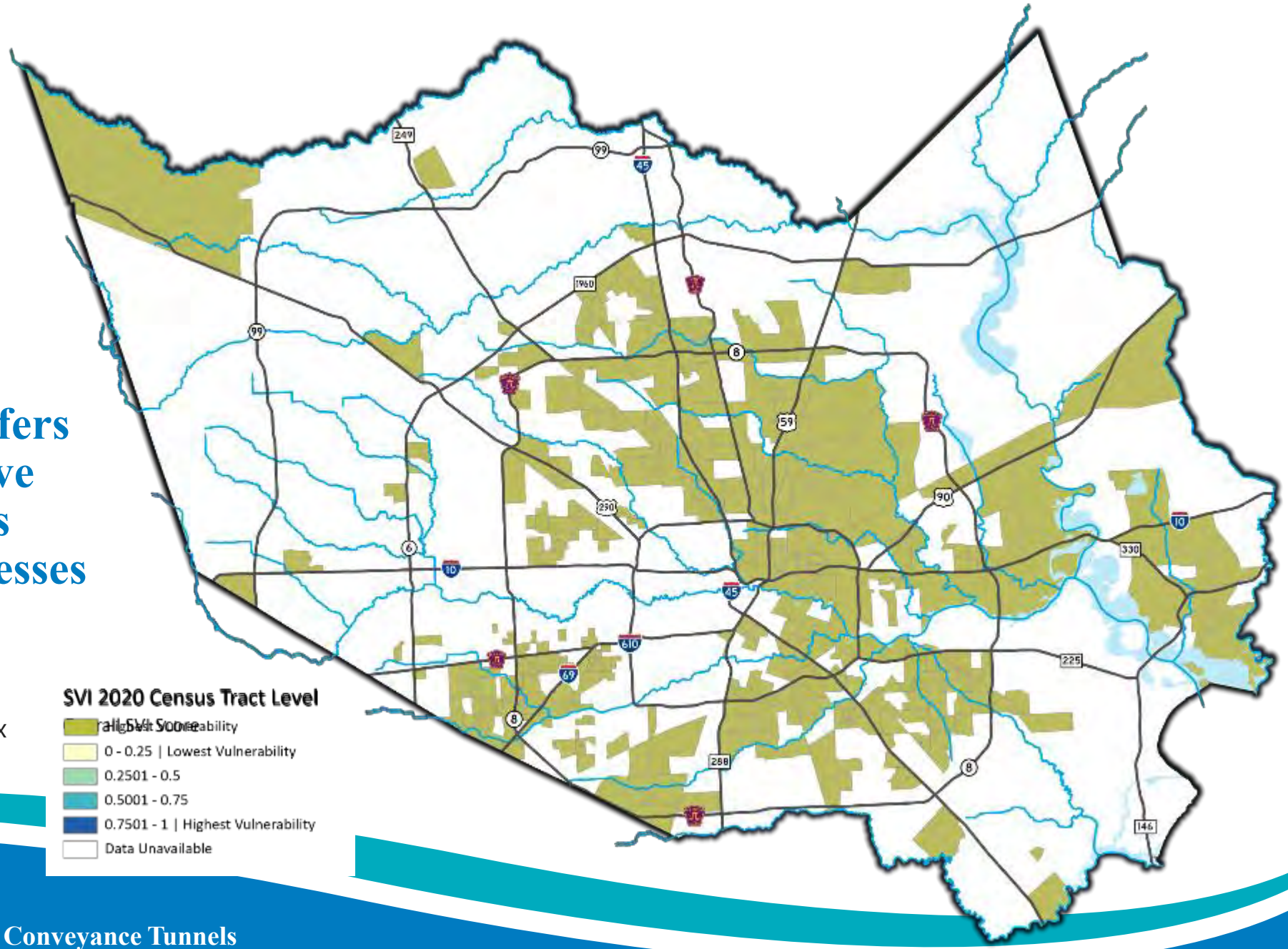
A concentrated area that has and will continue to flood repeatedly, with water in homes and businesses.



Socially Vulnerable Communities

Social vulnerability refers to the potential negative effects on communities caused by external stresses on human health.

CDC/ATSDR Social Vulnerability Index



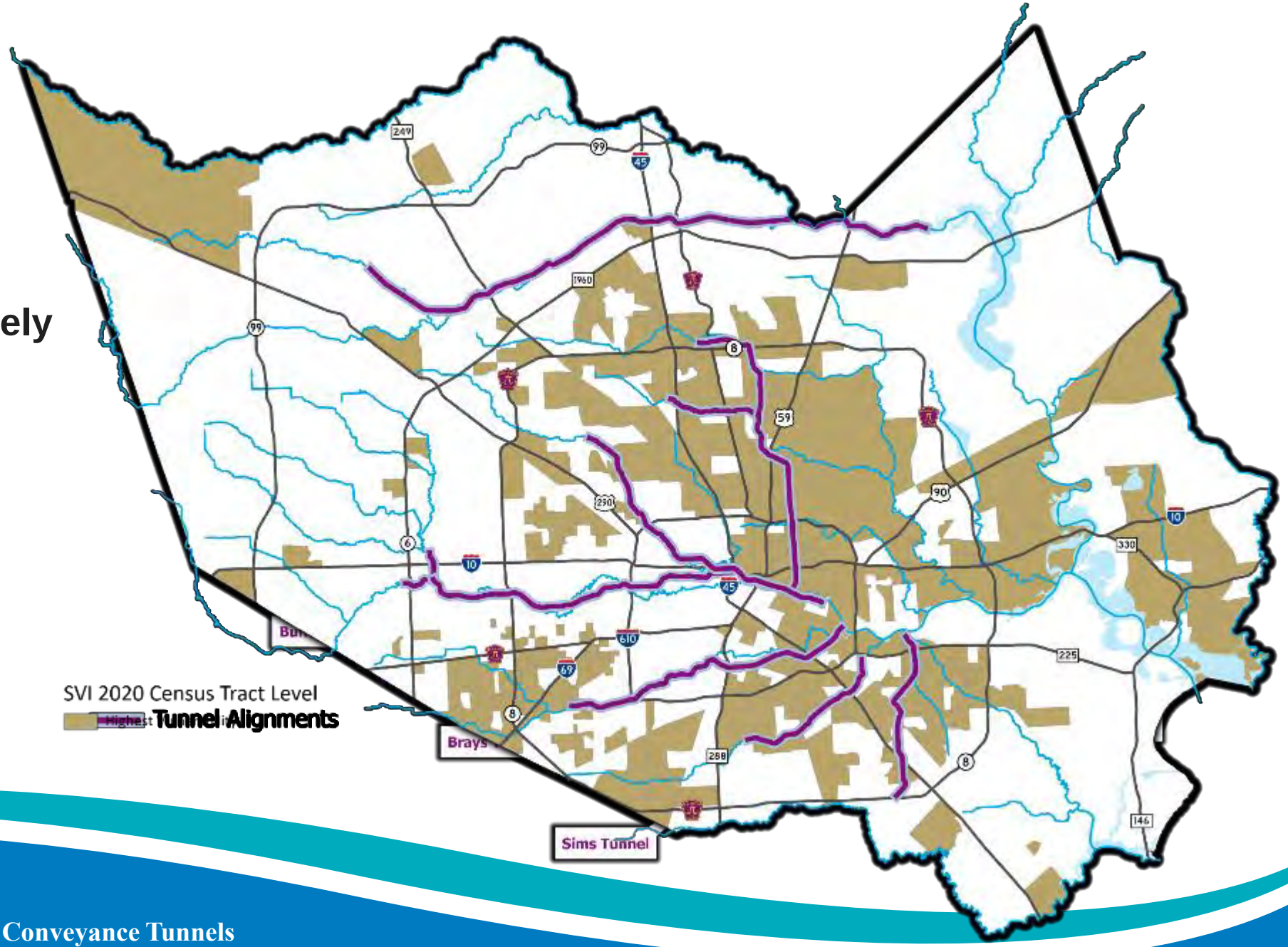
Potential Tunnel System

Where tunnels would likely be most effective and beneficial

80,000-120,000 future instances of flooding avoided

Est. Cost $30 Billion

All alignments are preliminary and will be refined in Phase 3



Potential Tunnel System Summary

	Length (miles)	Diameter (feet)	Inlets and Outlet	Estimated Conveyance (cfs)	Range in Ground Cover (feet)
Brays Bayou	16	35	3	8,310	45-120
Buffalo Bayou	25	30-40	7	12,020	60-140
Clear Creek, Berry and Vince Bayous	9	35	3	7,310	46-87
Greens, Halls and Hunting Bayou	18	35	4	9,740	55-125
Halls and Hunting Bayou	16	35	4	10,370	58-125
Little Cypress Creek, Cypress Creek	24	35	4	10,210	39-97
Sims Bayou	8	35	2	7,260	52-153
White Oak Bayou	16	35	3	10,300	54-104

* Estimated using Atlas 14, 100-year storm event over 100-year service life

Potential Advantages of Tunnel System

- Expands options for flood damage reduction
- Makes our stormwater network more robust
- Reduces community disruption and increases resiliency
- Reduces environmental impact

Tunnel System Considerations & Points to Remember

- Criteria for federal funding continues to evolve
- Preliminary cost estimate for tunnel system: $30 Billion
- New technology often involves learning as you implement
- Tunnel system would be an addition to our existing stormwater management network
- Weather will always be unpredictable
- Flooding will always be a possibility in Harris County
- Everyone should purchase flood insurance!

Investigation of Tunnels Continues

Where we are headed

Phase 3 Investigation

- Understanding the need and working with the Community
- Advancing the tunnel system design
- Quantifying the benefits
- Investigating funding sources

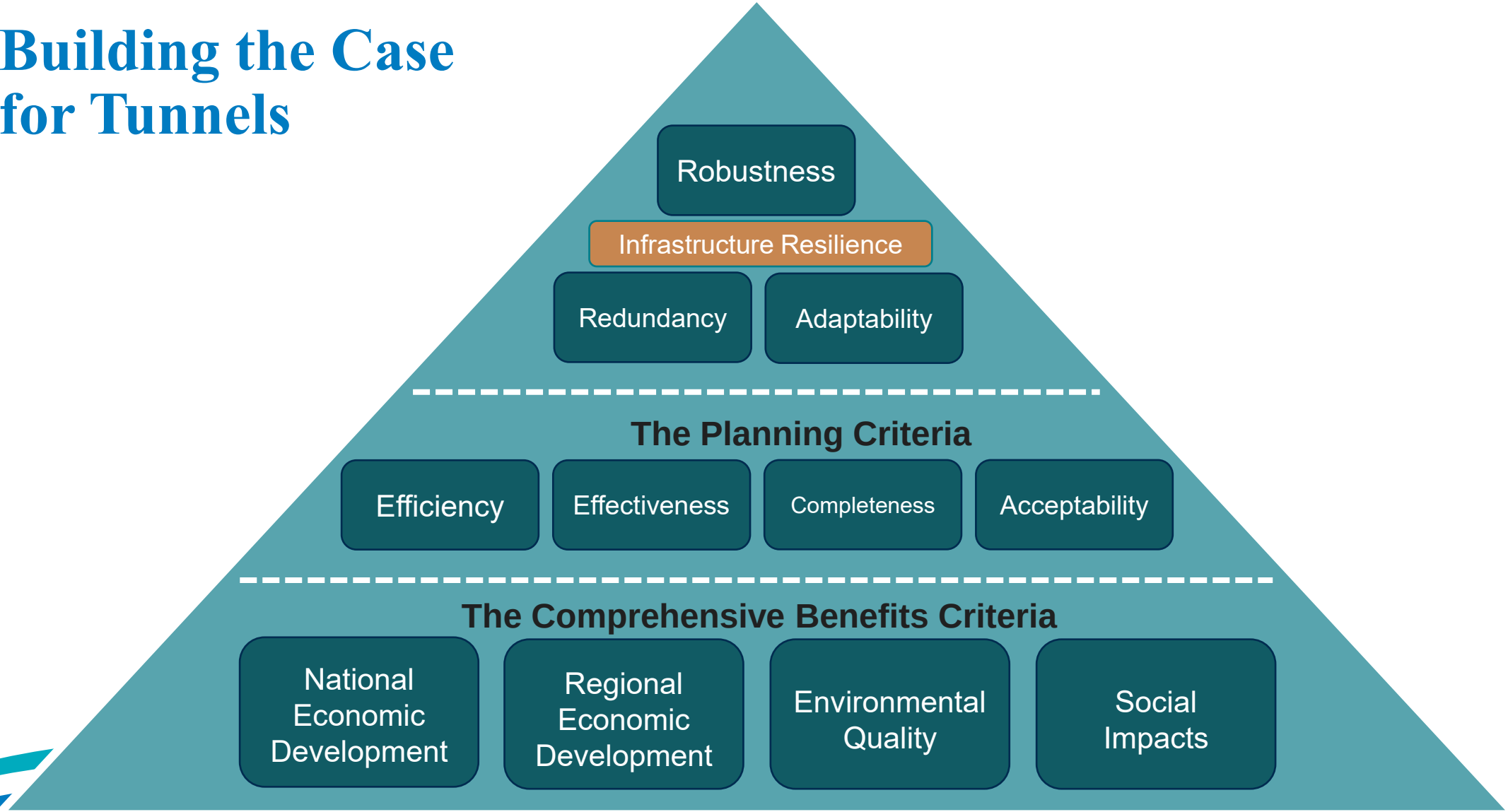
Working with the Community

- Educate the public on how a tunnel system can benefit our neighborhoods
- Develop clarity on where improvements are needed most, and which flood damage reduction tool makes sense in varying locations
- Capture input that will inform the project team as they continue to evaluate
- Measure public support for adding a tunnel system to our flood risk reduction strategy and tools
- ***You have an important role to play in this decision.***

Advancing the Design:
Analyzing Approximately 130 miles of a Potential Tunnel System

- Determine how tunnels will most effectively integrate with our existing network and planned improvements to the network
- **Identify ways to mitigate downstream impacts**
- Finalize a tunnel system that provides the greatest flood damage reduction benefits, while considering cost and potential funding
- Quantify flood damage reduction benefits through drainage modeling, engineering and design, cost estimating, and other means

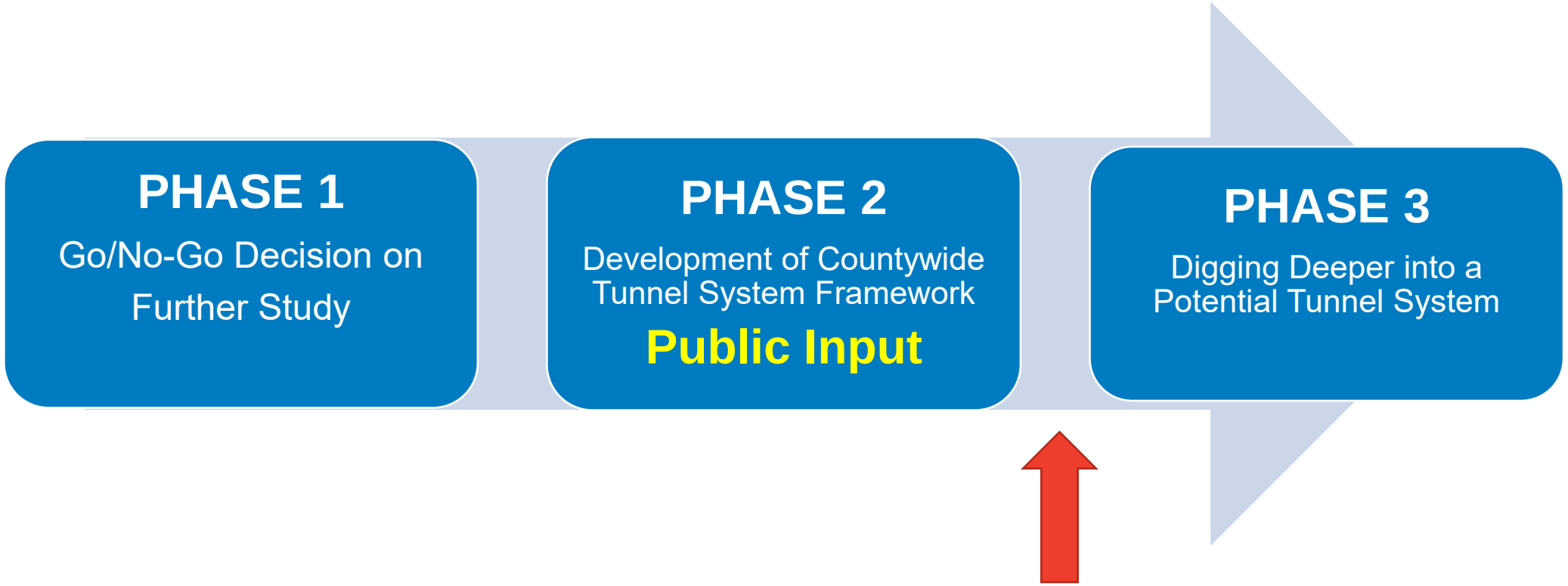
Building the Case for Tunnels



Securing Funding

- Complete the necessary work to position a tunnel system for State and Federal funding.
- Due to the scale of the potential system, minimizing the burden on Harris County taxpayers is an important objective

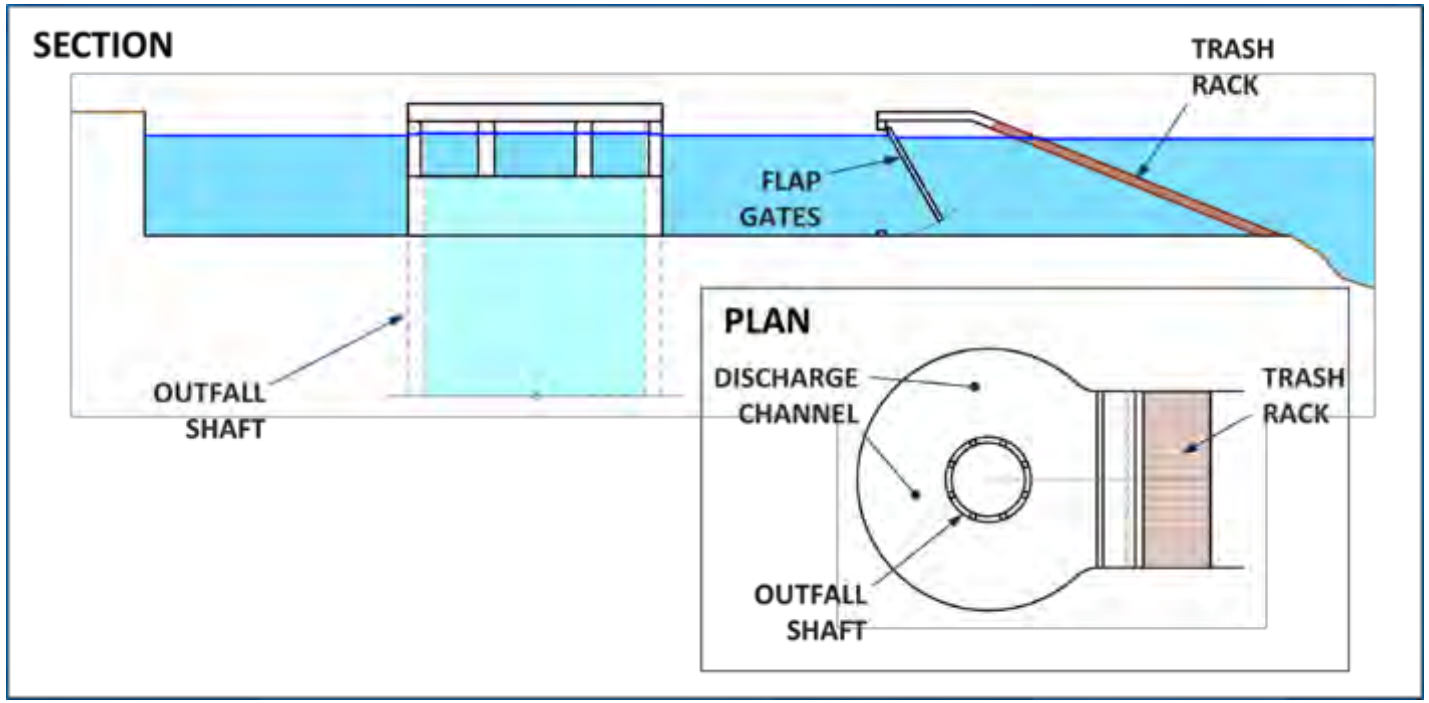
Where we are today

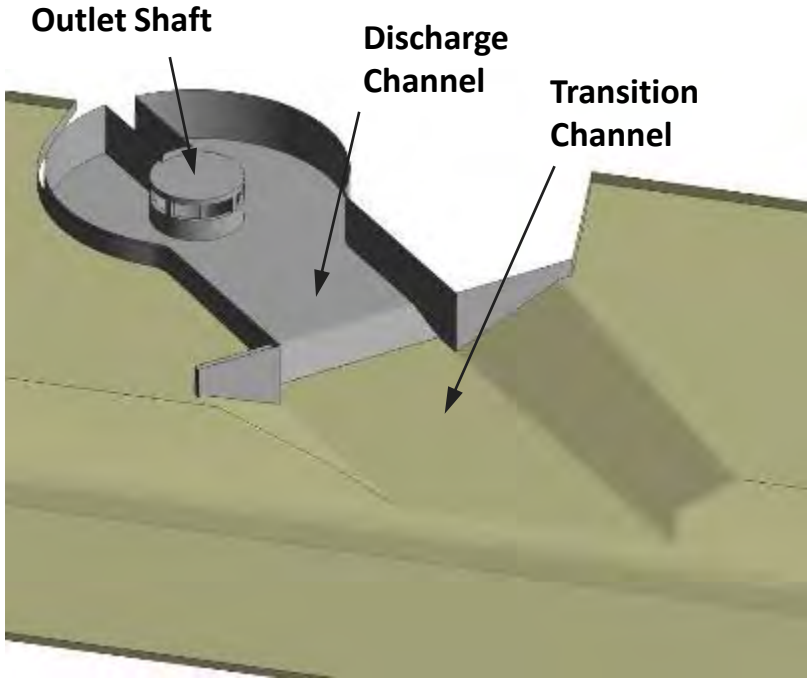


Port of Houston – Phase 3 Study Items

- Sedimentation
- Ship Channel Velocities
- Water Surface Elevation Changes related to Structures
- Coordination with Texas Coastal Spine Project
- Tailwater Conditions
  - Storm Surge Impact
  - Sea Level Rise
  - Subsidence

Outfall System

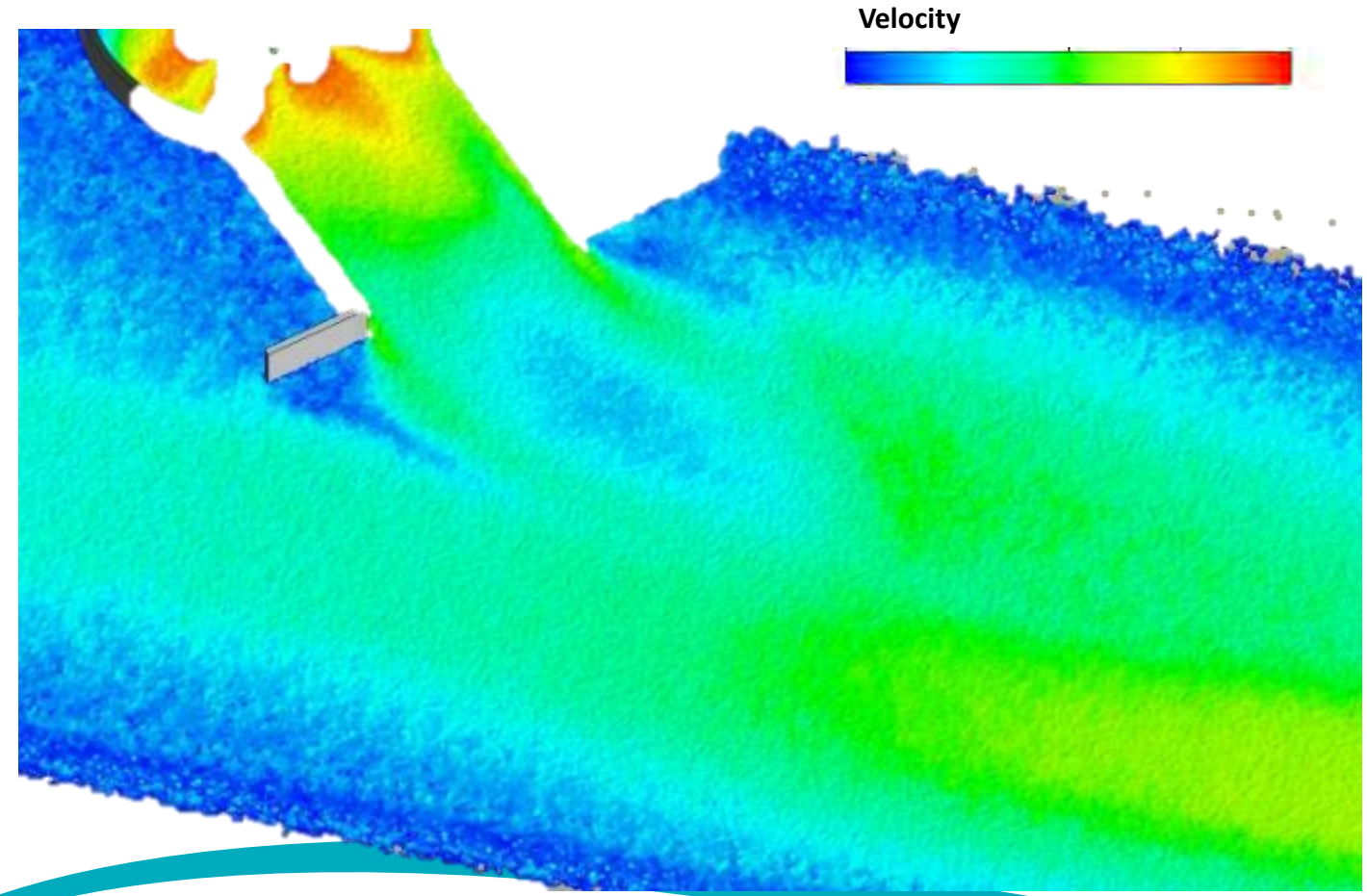


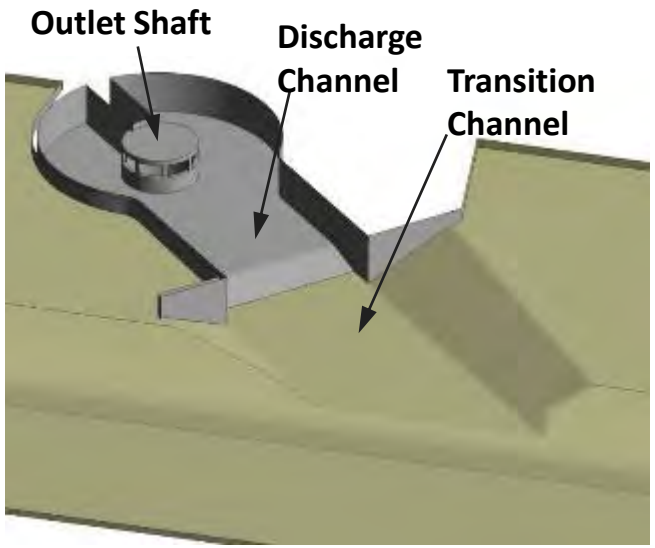


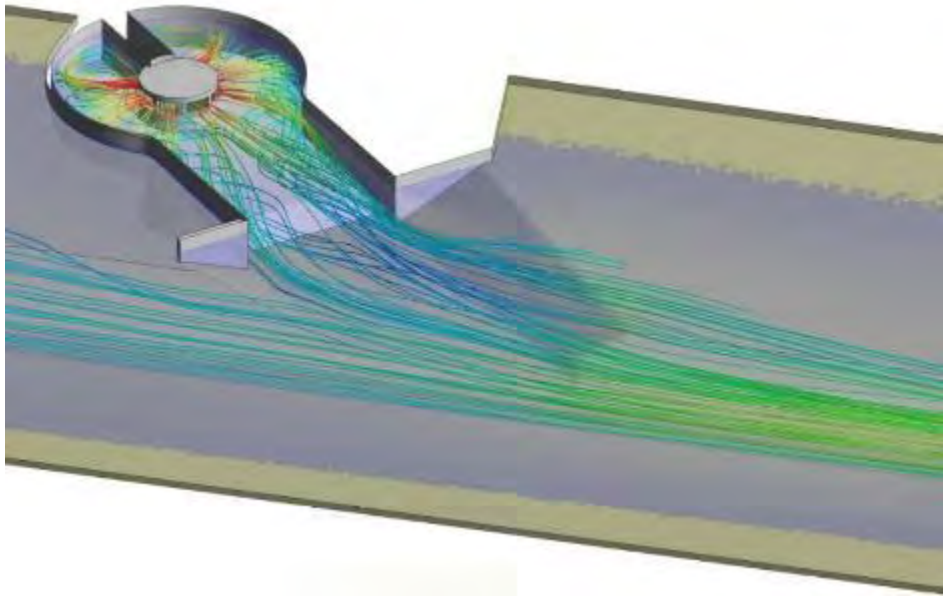
Downstream Change in Discharges

- Modeling results show an increase in flow rate in the Ship Channel due to tunnel discharges
- To avoid unacceptable impacts, the tunnels would have to discharge into the Ship Chanel
- To evaluate impacts of discharging into the Ship Channel two scenarios were modeled:
    - 100-year Atlas 14 with no-surge
    - 100-year Atlas 14 with 9-ft surge (10-year water level at the Turning Basin)

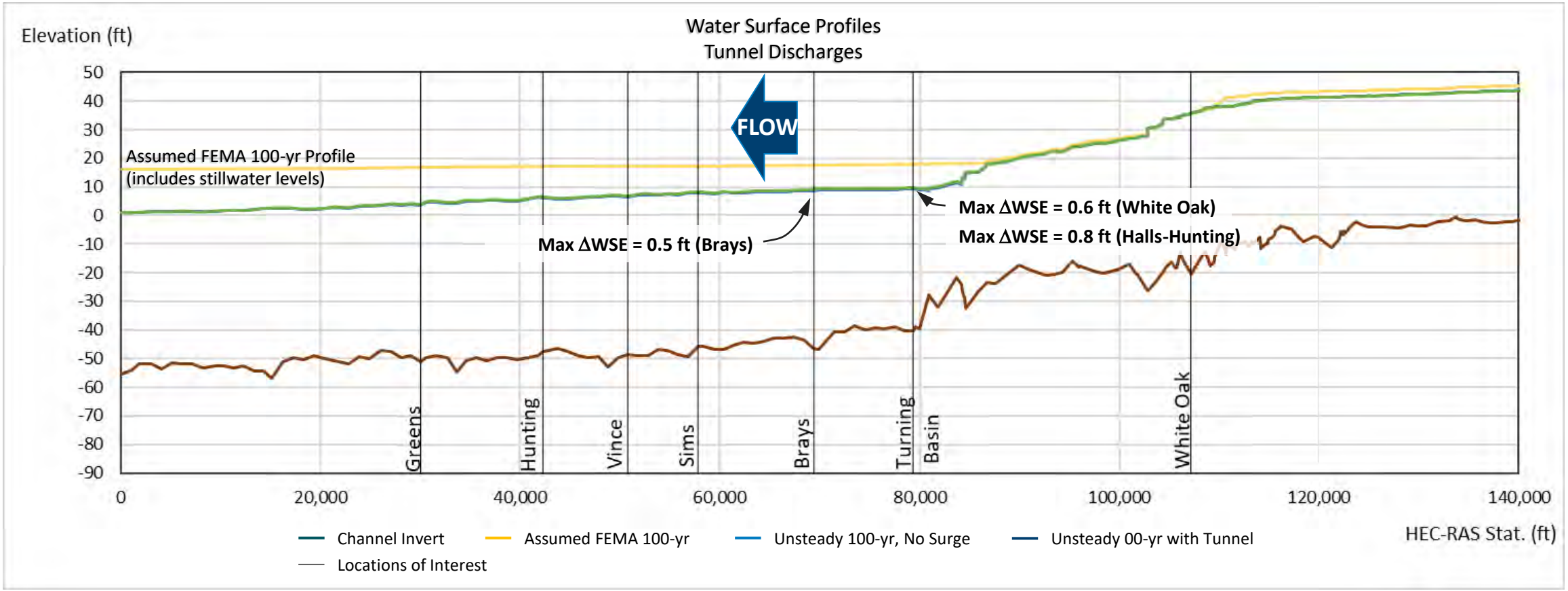
Hydraulic Conditions Near Outfall





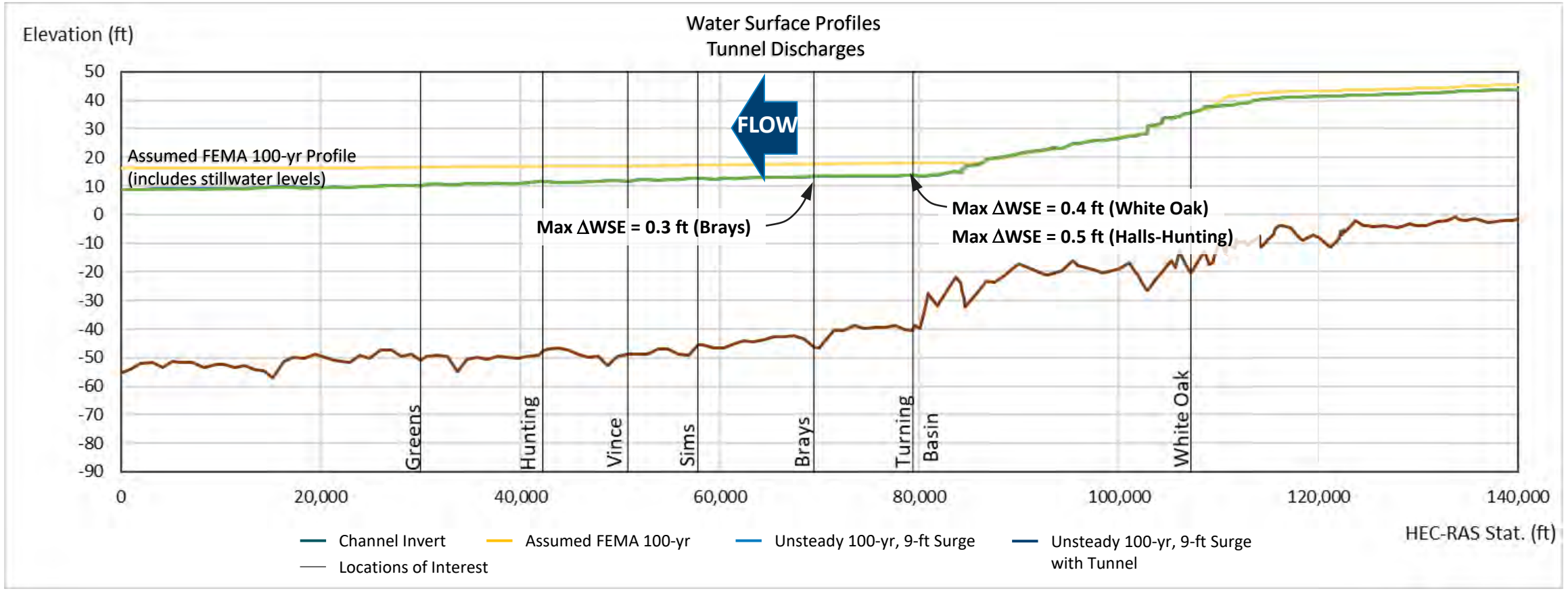


Downstream Water Surface Elevation Changes



No Surge

Downstream Water Surface Elevation Changes



9-ft Surge

Water Quality Considerations

- Contaminants of Concern in the Bayous and Houston Ship Channel
  - **Nutrients**
  - **Bacteria**
  - Chlorophyll a
  - Dioxin/PCBs
  - Low DO

The project will not change the total loading of either of these potential contaminants and loading tends to be more important than concentrations for these parameters.

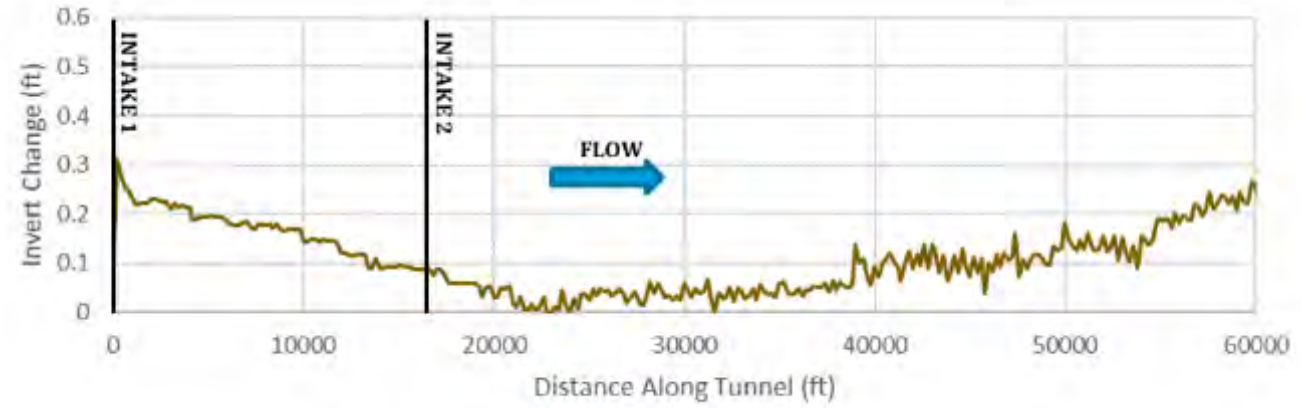
- Water Quality Concerns related to the Tunnel Project
  - Salinity or lack thereof
    - Considering the variations that currently occur in the Ship Channel, potential changes in salinity due to the tunnel project would be minor.
    - Modeling results indicate the dilution will be sufficient to minimize the impact of concentrated stormwater discharges at the location of the outfalls

Water Quality Considerations cont.

- DO
  - Anoxic conditions could form inside the tunnel if the tunnel remains stagnant for a long period of time (days).
  - If the tunnel remains full and is used again during a storm event, water with low or essentially no oxygen could be discharged into the receiving water body.
  - Low DO could be a significant issue if the runnel remains full; therefore, dewatering the tunnel is recommended.

Sediment Transport and Deposition - Tunnel

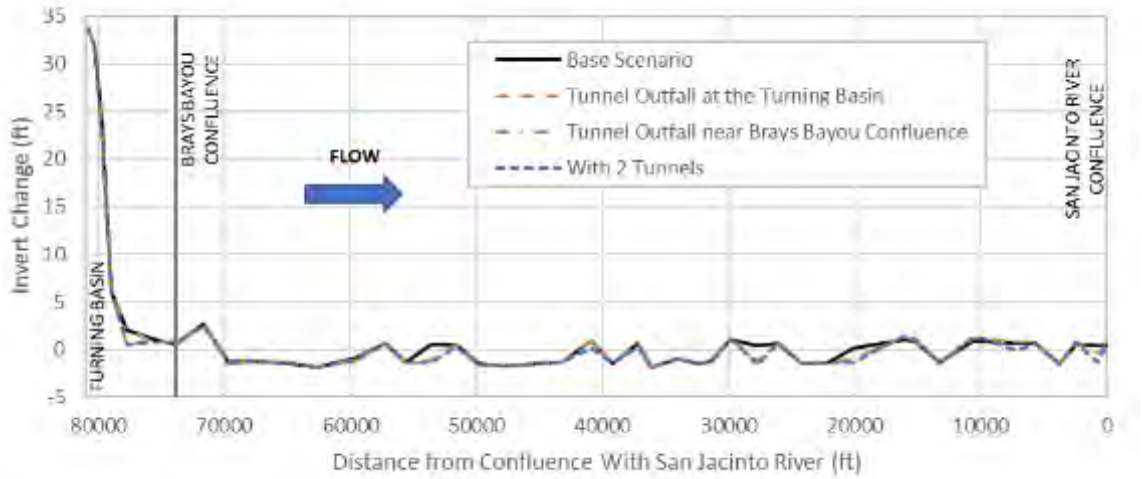
- Example profile of sediment accumulated after 3-years



- Approximate sediment transport/accumulation values per year:
  - 3,300 tons of suspended sediments would be diverted into the tunnels
  - 2,800 tons may accumulate in the tunnel
    - 1,000 tons will accumulate along the invert of the tunnel
    - 1,800 tons would pass as bed load and reach the outlet shaft
      - A portion would likely be resuspended at the shaft
      - The rest would accumulate in the shaft

Maintenance procedures, that include dewatering the tunnel, would have to be implemented to manage sediment in the tunnel

Sediment Transport and Deposition– Ship Channel



- The HEC-RAS FEMA effective model was used to evaluate potential for sediment accumulation in the Houston Ship Channel
- Four Scenarios
  - Existing Conditions
  - Tunnel discharge at the Turning Basin
  - Tunnel discharge near the Brays Bayou confluence
  - Discharges from the two tunnels
- **Tunnel discharges will result in negligible changes in bed elevation due to discharges from the tunnels over 3-years modeled**

Members of GHPB we need your input!

- Please submit your questions about the Tunnel feasibility study
  - Comment Link is at hcfcd.org/tunnels

We want to hear from you.

Please visit **hcfcd.org/tunnels** to learn more
about the **Feasibility Study of Stormwater Conveyance Tunnels**,
ask questions and sign up for our mailing list.