FLOOD RISK MANAGEMENT OBJECTIVES AND PRIORITIES FOR THE CITY OF BELLAIRE

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APRIL 4, 2022

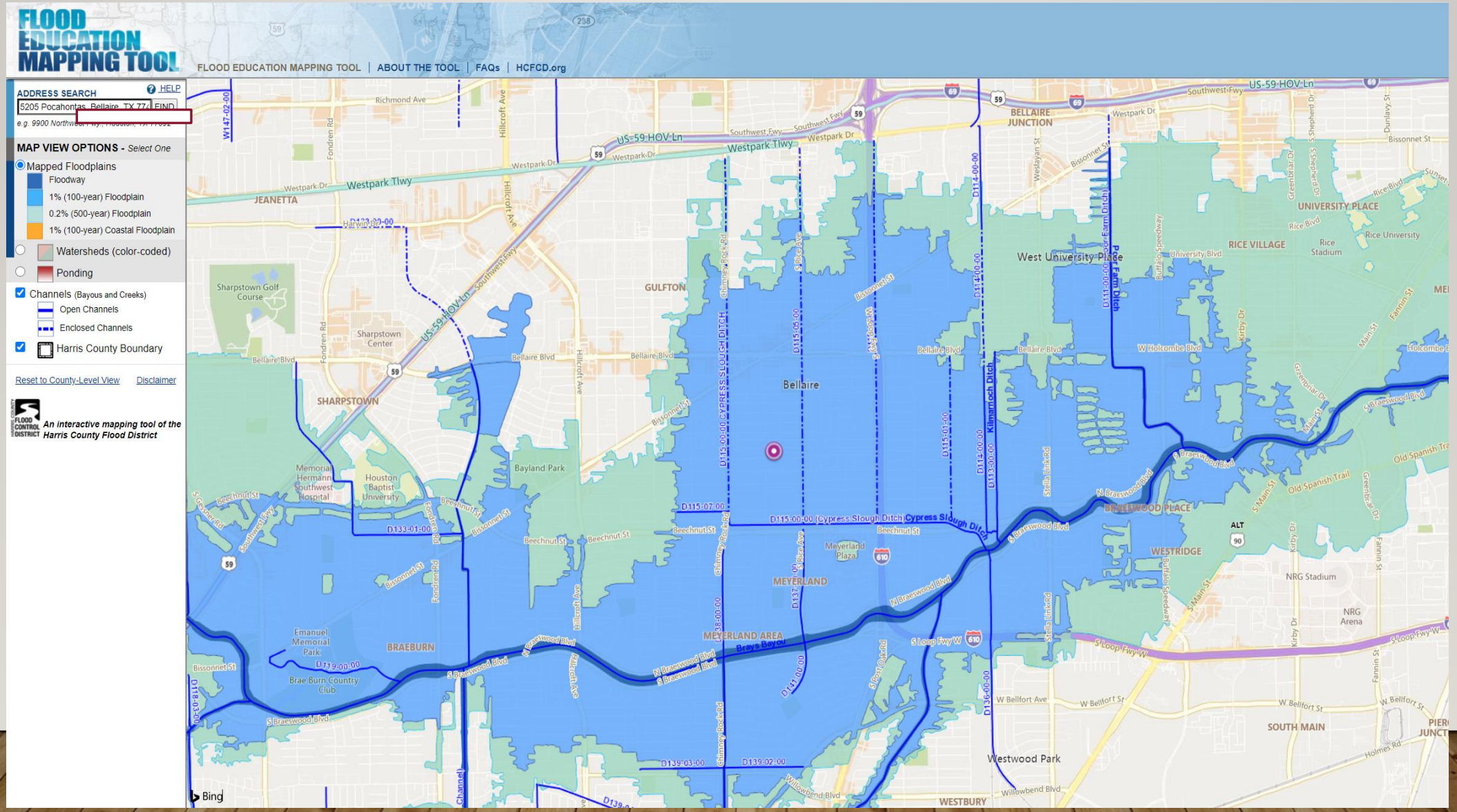
GOALS FOR TODAY

- Initiate the discussion on Council-level flood risk management objectives and priorities which will inform future decisions to be made by City Council.
  - Anticipate future discussions and/or workshops will be necessary to continue this effort.
- To elevate our collective understanding of the complex causes of flooding and the muti-faceted challenges associated with delivering meaningful flood risk reduction.
- Chart a path to act quickly and decisively on NEAR-TERM beneficial actions within a LONG-TERM strategic framework
  - Desire to deliver a "goal-oriented" infrastructure program, focused on achieving the desired outcome (level of protection / risk reduction) the for the City in the most cost-effective and cost-efficient manner.
  - Must provide City Staff (and its consultants) clear direction on what we hope to achieve, by when, and at what level of cost

FLOODPLAIN MANAGEMENT 101

FLOODPLAIN MANAGEMENT 101

https://www.harriscountyfemt.org/



FLOODPLAIN MANAGEMENT 101

- 100-year Flood / 1% Annual Exceedance Probability (AEP) / Base Flood Elevation
  - A rain event / flood which has a 1% chance of occurring in any given year
  - Typically referred to as the Effective BFE elevation for FEMA / regulatory purposes
  - Also known as the Special Flood Hazard Area (SFHA)
  - Flood Insurance required for a mortgage in the SFHA
- 500-year Flood / 0.2% Annual Exceedance Probability
  - A rain event / flood which as a 0.2% chance of occurring in any given year
  - Also known as the Moderate Flood Hazard Area (MFHA)

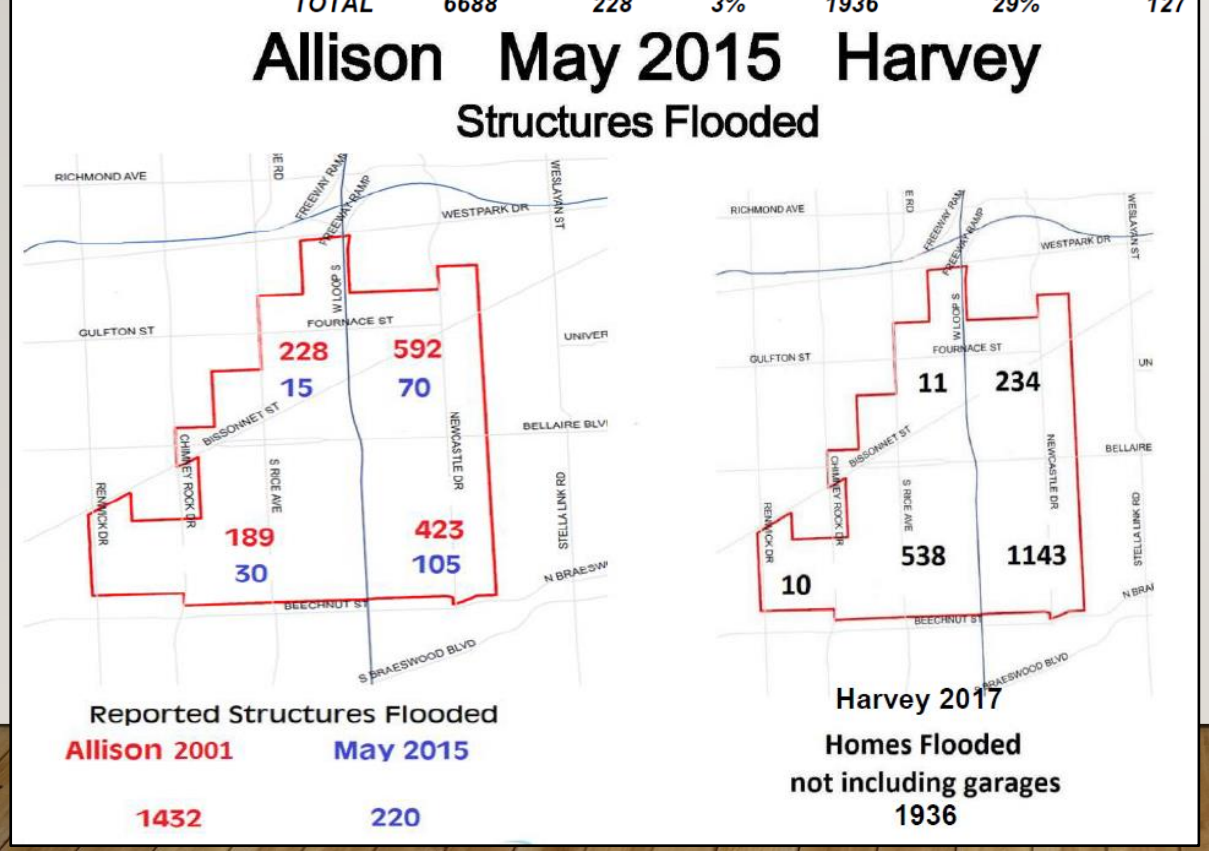
FLOODPLAIN MANAGEMENT 101

- Flood Damage Prevention Ordinance
  - Requires Finished Floor Elevations to be 12" above the BFE shown on the effective Flood Insurance Rate Map (FIRM) or the 500-yr floodplain elevation, whichever is higher.
  - Permits enclosed areas below the FFE to be used only for vehicle parking, building access, and storage. Requires vents which allow water to enter, fill, and flow through this enclosed area.
  - For properties located in the Special Flood Hazard Area, generally no net increase in volume of material on the lot is allowed, preventing the filling of the floodplain.
- Drainage Criteria
  - **Residential:** Bellaire enforces lot coverage requirements but do currently not require mitigation for existing or new impervious cover.
  - **Commercial:** Bellaire enforces City of Houston Drainage Criteria, requiring mitigation (e.g. detention) for any new or disturbed impervious cover (new stricter standard)

IMPORTANCE OF DEVELOPMENT STANDARDS

SUMMARY

Description		Existing Homes	May 2015 Flood		August 2017 Flood		Flooded in Both Storms
			Structural Flooding	% Flooded Homes	Structural Flooding	% Homes w/Structural Flooding	
Tier I	Pre 1980	2313	122	5%	1039	45%	80
Tier II	1980-1993	1087	32	3%	291	27%	12
Tier III	1994-2007	2348	56	2%	554	24%	30
Tier IV	2008-Present	739	16	2%	47	6%	5
	Year Build Unknown	201	2	1%	5	2%	0
	TOTAL	***6688***	***228***	***3%***	***1936***	***29%***	***127***



*** As re-development activity occurs, and at-grade homes are replaced with elevated homes, we are incrementally reducing our flood exposure and improving our risk profile

TYPES OF FLOODING

- Fluvial (Riverine)
  - Related to the overflowing/overtopping of bayous
  - Basis for 100-year FEMA Floodplain / floodplain regulation
  - DOES NOT CONSIDER LOCAL BELLAIRE DRAINAGE INFRASTRUCTURE
- Pluvial (Urban)
  - Related to the conveyance of runoff to a receiving stream/channel
  - Considers streets, storm sewers, ditches, and minor channels
  - NOT CURRENTLY CAPTURED IN FEMA MODELS / FLOODPLAIN MAPS
- Degrees of flooding:
  - Nuisance flooding (street ponding)
  - Flooding which impacts mobility / emergency access (impassable roads)
  - Flooding which damages property (cars, houses, etc.)
  - Flooding which creates life safety risks (risk for drowning)

DEFINITION OF SUCCESS?

DEFINITION OF SUCCESS?

UNACCEPTABLE OUTCOME
(FLOOD WATER EVERYWHERE)

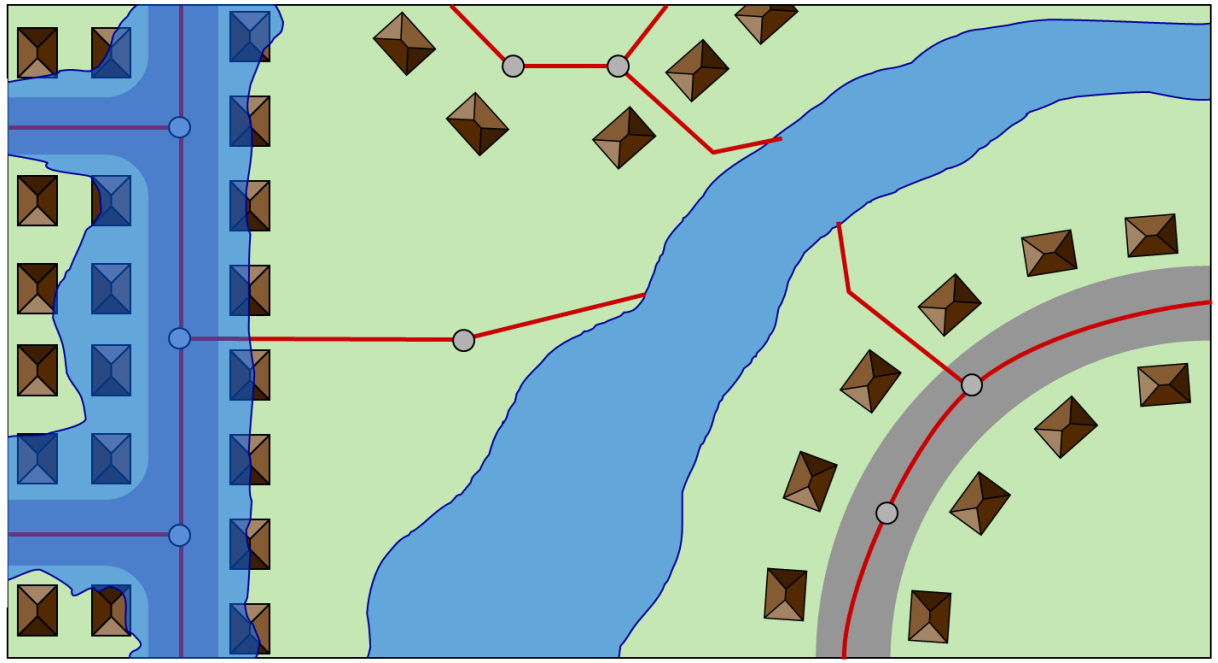
DEFINITION OF SUCCESS?

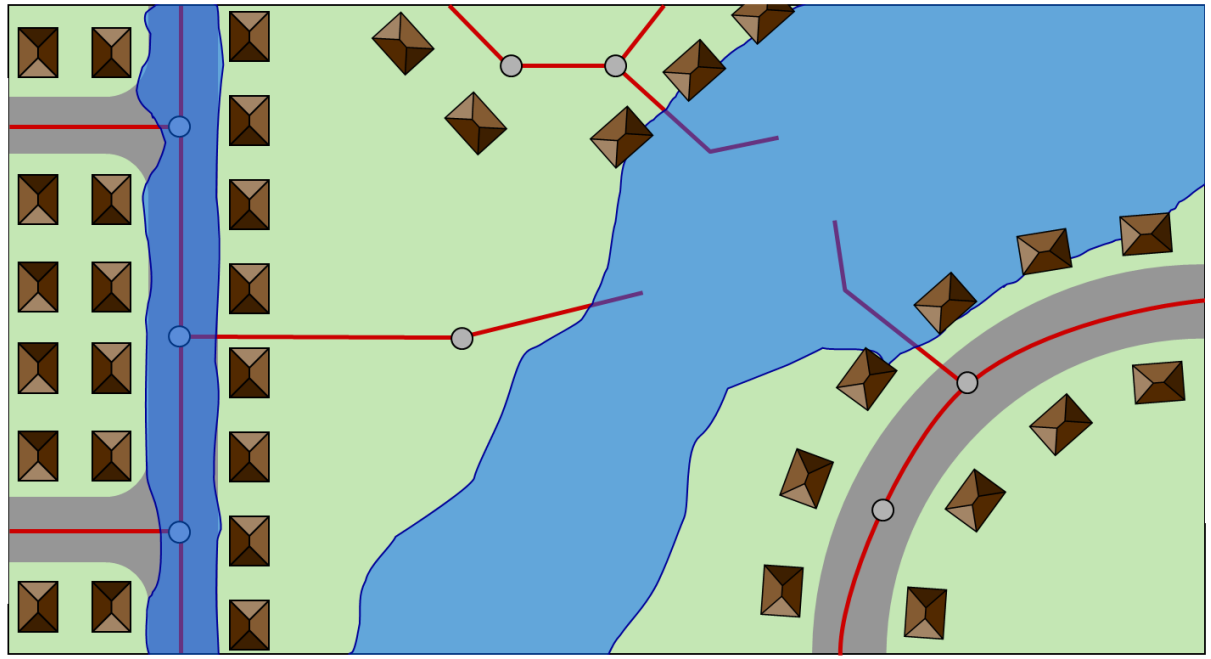
EFFICIENT USE OF TAXPAYER DOLLARS
(STRUCTURES PROTECTED)

CONSTRAINTS / REALITIES

- Streets are an integral component of our drainage system
  - **Primary Drainage System:** storm sewers (or in some areas, ditches)
    - Note: it is typically not cost effective to rely on storm sewers exclusively to meet our drainage criteria. In larger storm events, we rely on the streets to carry/store runoff.
  - **Secondary Drainage System:** overland conveyance / storage in the streets
    - Note: goal is to have cascading overland flow which limits ponding in a street to an acceptable level (e.g. does not leave the ROW)
- Brays Bayou water levels can affect or entirely control the performance of local drainage
- No adverse impact policies
  - Water does not follow jurisdictional boundaries
  - Cannot through our actions worsen flooding elsewhere (typically downstream)
  - Flooding in our neighborhoods effectively serves as "detention" for Brays Bayou. If we improve conveyance and are able to transfer that water to Brays Bayou, we must mitigate the impact of that water on Brays Bayou. This can be very challenging and costly.

“MOVING THE FLOOD” / NO ADVERSE IMPACT





THE REALITY OF FLOODING IN HOUSTON / BELLAIRE

- Every rain / flood event brings a combination of fluvial and pluvial flood risks.
  You can flood because of:
  - Maintenance issues (e.g. clogged storm sewer)
  - Deficiencies in local drainage (local inlets, storm sewers, and street)
  - Deficiencies in semi-regional drainage (major storm sewers / ditches / channels)
  - Deficiencies in regional drainage (Brays Bayou)
  - An unusual / extreme storm event different than that assumed in the design
  - A combination of any or all of these
- ~75% of all structures flooded in TS Alison were outside of the 100-year Floodplain
- We must recognize that climate and rainfall patterns are changing:
  - Definition of a 100-year event has changed recently from 13 inches to 17 inches
  - Project Brays was designed 10+ years ago to provide a ~100-yr level of service for the bayou
  - Based on most current data, it will provide approximately a 25-year or 50-yr level of service
  - Accordingly, flood risk management can feel like a never-ending battle (with moving goal posts)

SUMMARY OF ONGOING MAJOR PROJECTS IMPACTING BELLAIRE

PROJECT BRAYS

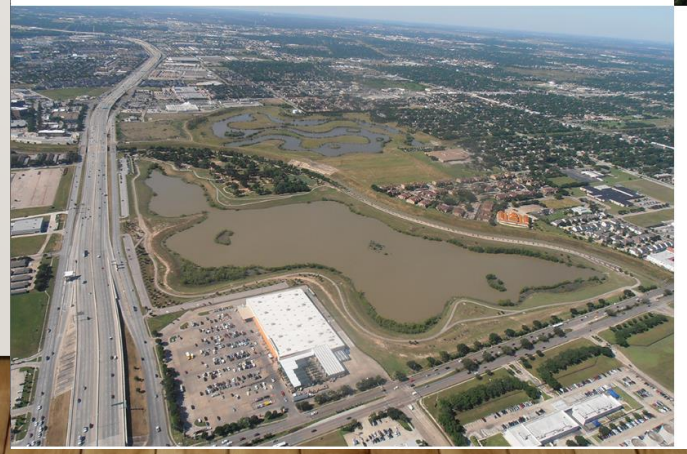
- USACE / HCFCD Partnership
- $480M Overall Program – 20 years
- 75 individual project components
- Currently working on:
  - Hillcroft Bridge
  - Chimney Rock Bridge
  - South Rice Bridge
  - Buffalo Speedway Bridge
  - Brays Bayou Channel Widening
- Program Completion: ~2022
- https://www.projectbrays.org/

Channel Modifications

Approximately 21 miles of the channel has been modified to increase the amount of stormwater the bayou can carry. Beginning at the mouth of Brays, the channel has been widened and deepened 18 miles west to Fondren Road. An additional six miles of the channel was widened and deepened, beginning at Old Westheimer Road and continuing upstream to Highway 6.

Bridge Modifications

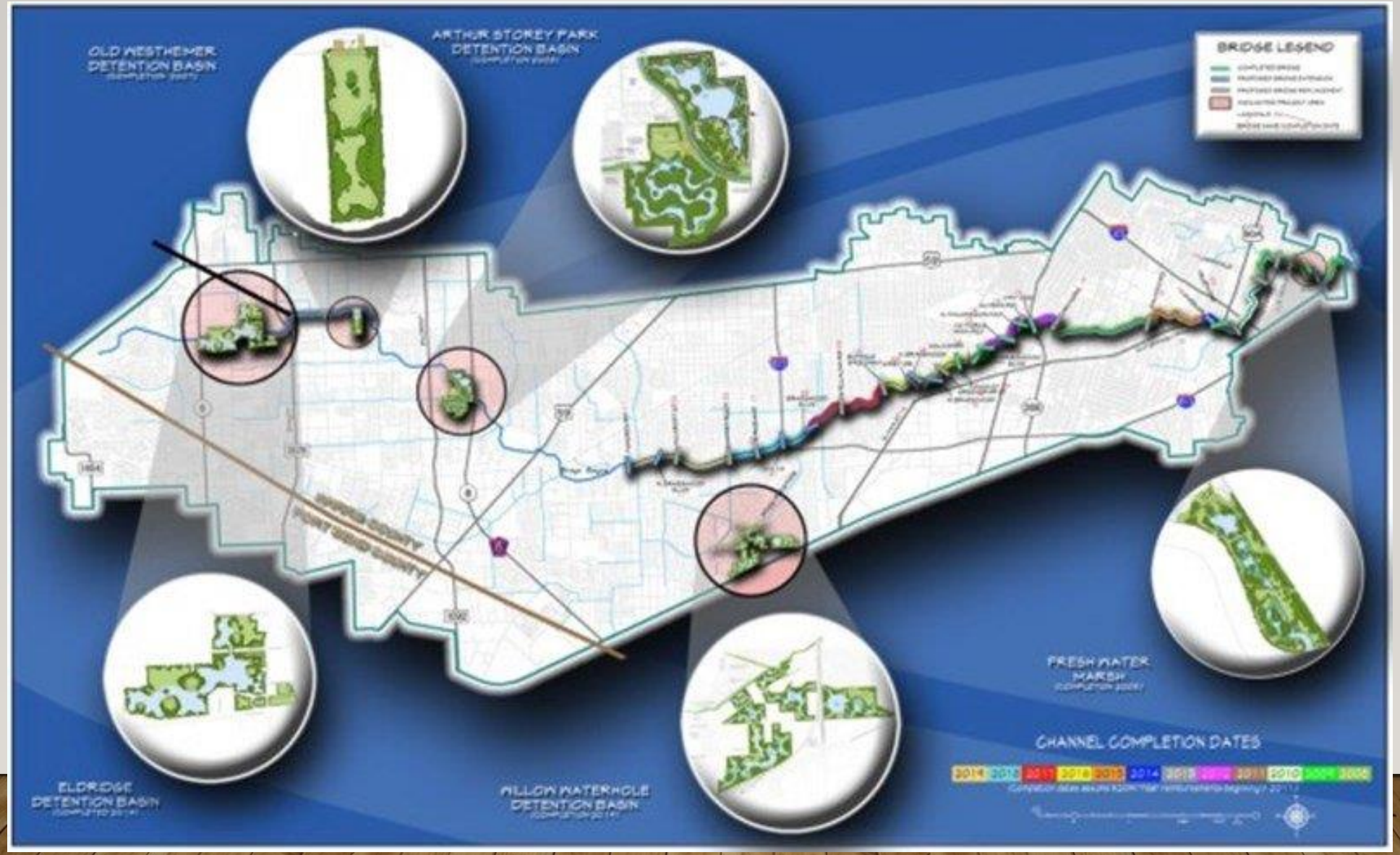
Modifications will be made to 32 bridges along Brays Bayou to allow for the increased flow capacity.



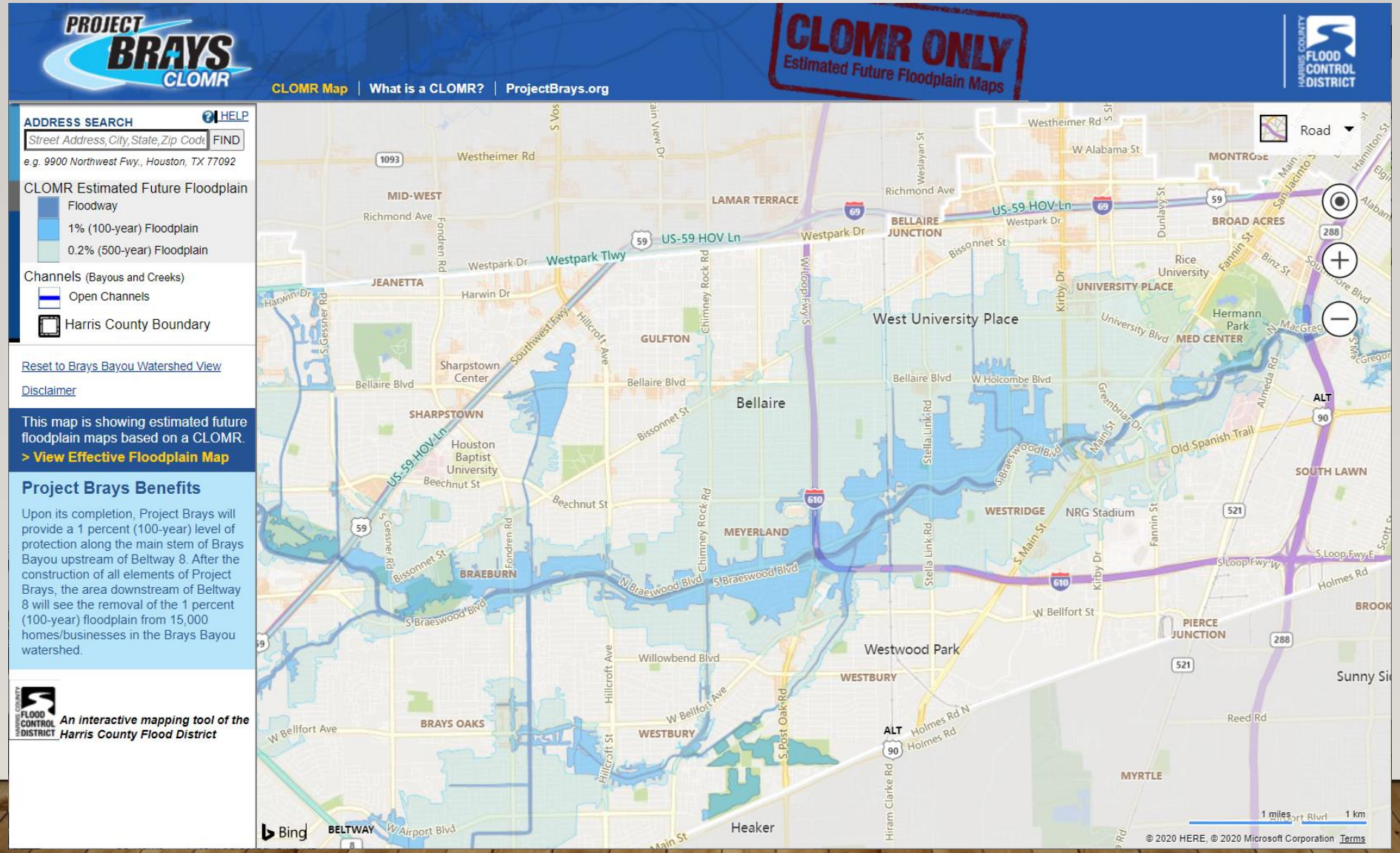
Stormwater Detention Basins

Four stormwater detention basins have been created to hold approximately 3.5 billion gallons of stormwater and cover about 900 acres. A stormwater detention basin is an area where excess stormwater is stored until the water level in the channel recedes, allowing the stormwater to flow away safely.

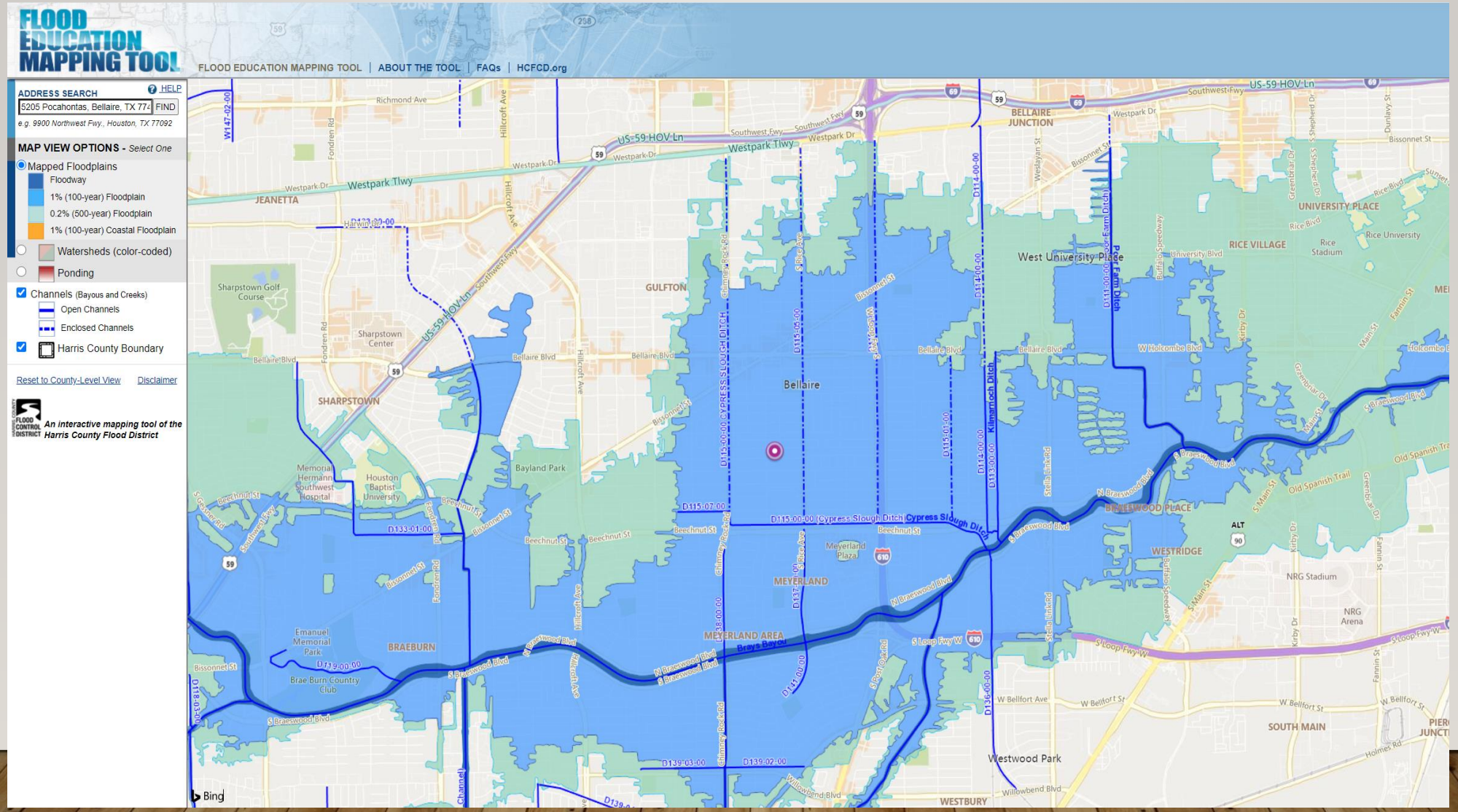
PROJECT BRAYS



PROJECT BRAYS BENEFITS



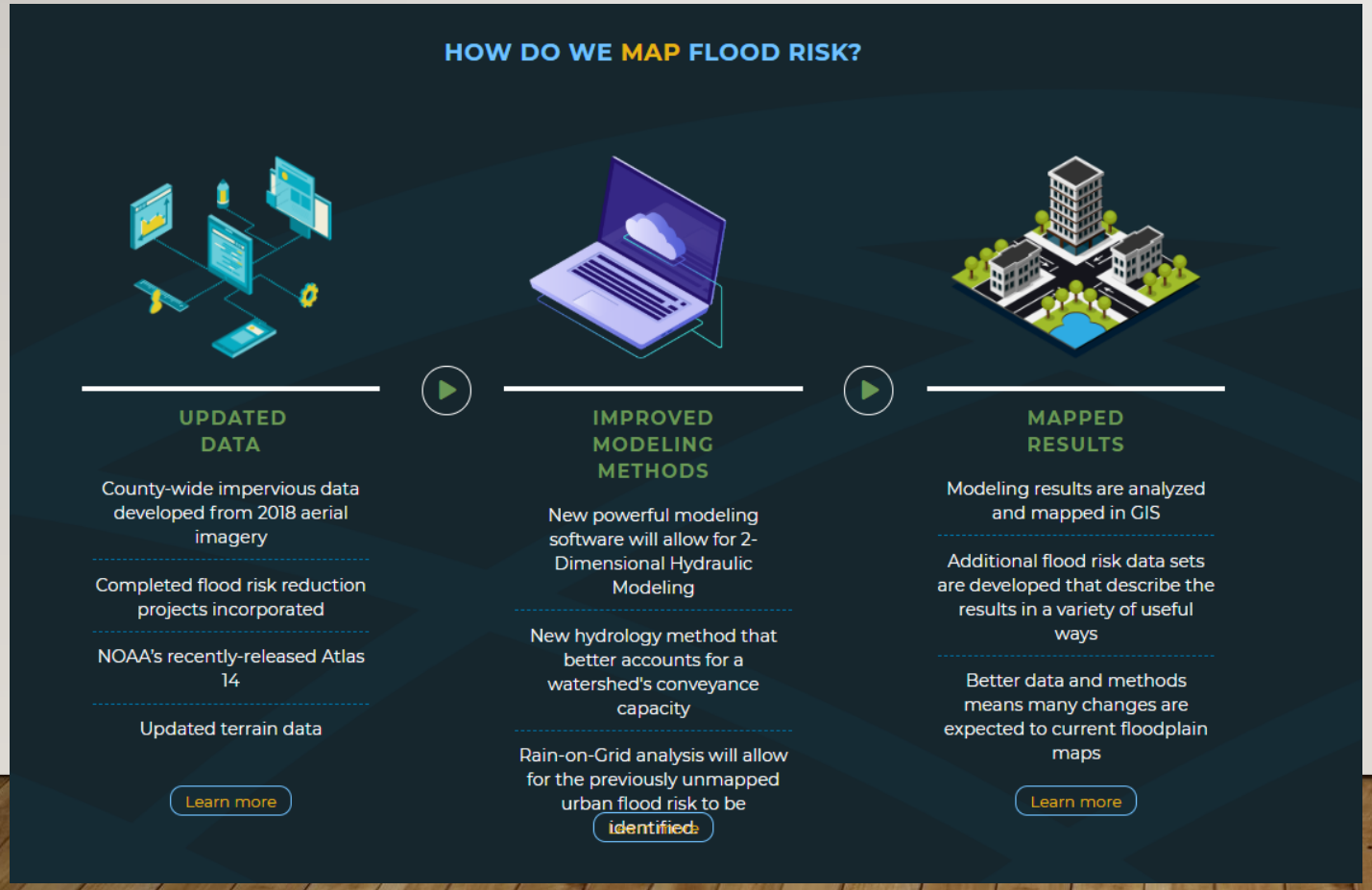
BRAYS BAYOU EFFECTIVE FLOODPLAIN MAP

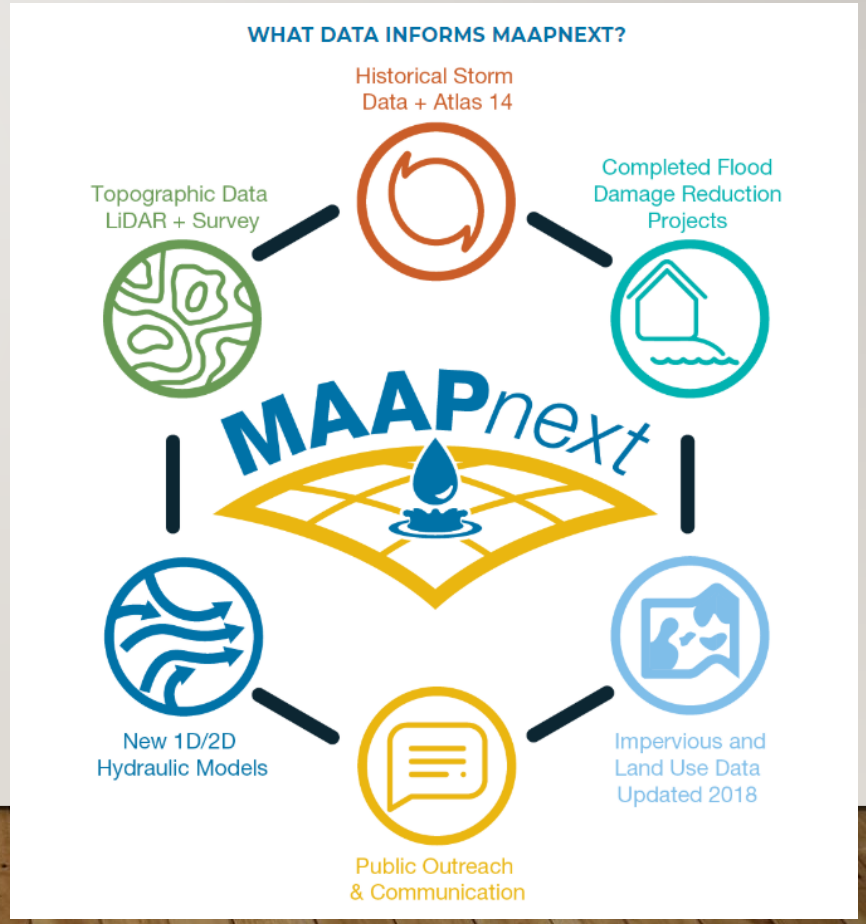


MAAPNEXT – NEW FLOODPLAIN MAPS IN 2023

- Effective Floodplain maps assume 13” over 24 hours for the 100-year and 19” over 24 hours for the 500-yr
- MAAPnext Floodplain maps will assume 17” over 24 hours for the 100-year and 25” over 24 hours for the 500-yr

https://www.maapnext.org/

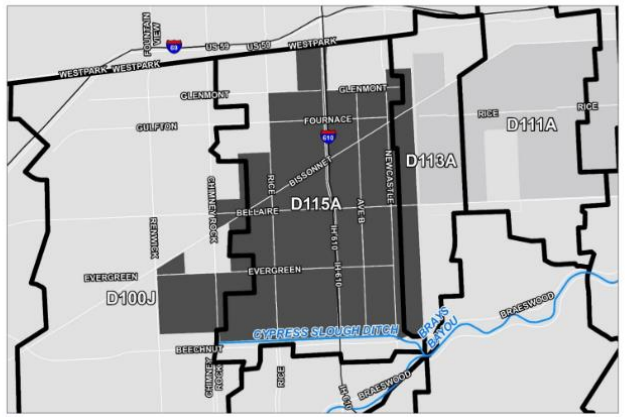




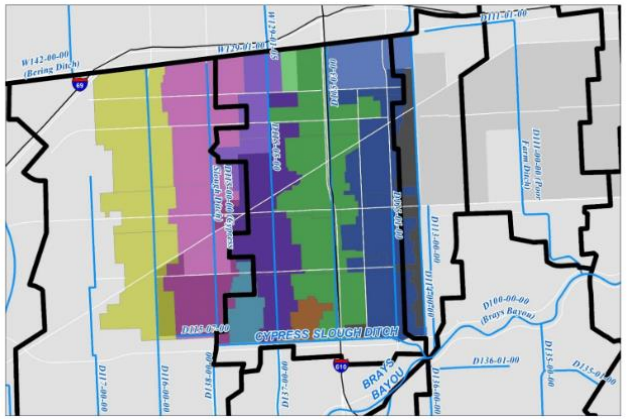
BELLAIRE MASTER DRAINAGE CONCEPT PLAN

- $700K study in partnership with HCFCD and TxDOT (funding split between all three)
- Focused primarily on the "semi-regional" drainage system
- Opportunity to access multi-billion dollar HCFCD Flood Bond Program
- Overall challenge:
  - Bellaire is very flat – hard to convey water
  - Our drainage infrastructure is generally very old, and was not designed to current standards
  - Brays Bayou is very close – and high tailwater levels prevent efficient conveyance within Bellaire
  - Other areas sheet-flow into Bellaire, exacerbating problems

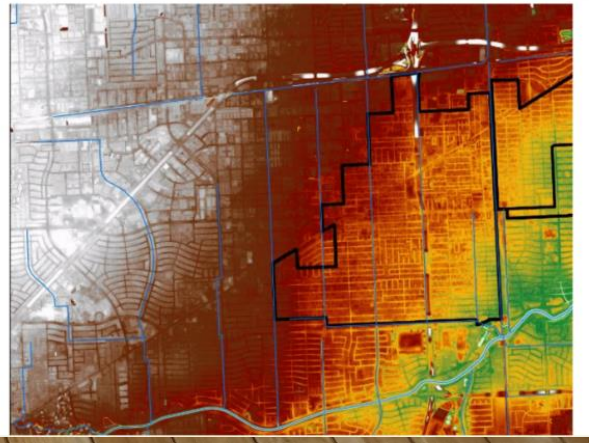
Existing Conditions – D115 Sub-Basin



Existing Conditions – Local Drainage

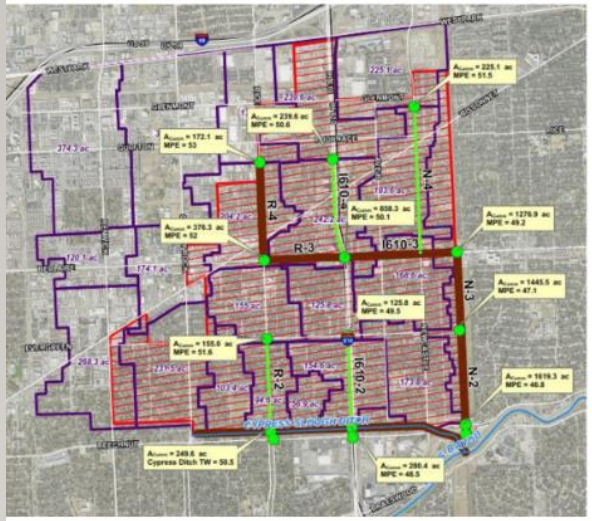


Existing Conditions - Sheetflow



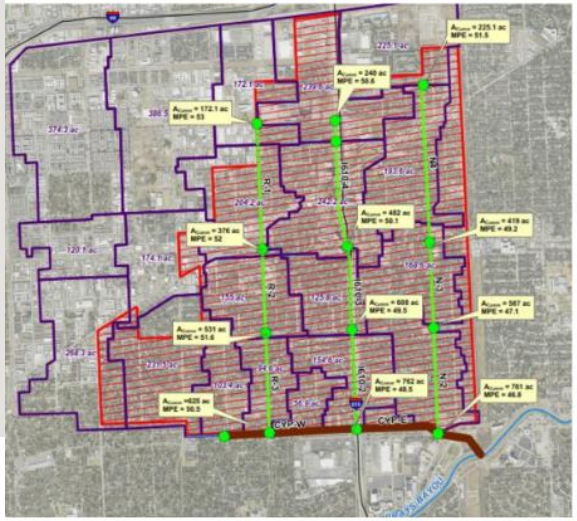
BELLAIRE MASTER DRAINAGE CONCEPT PLAN

Concept A



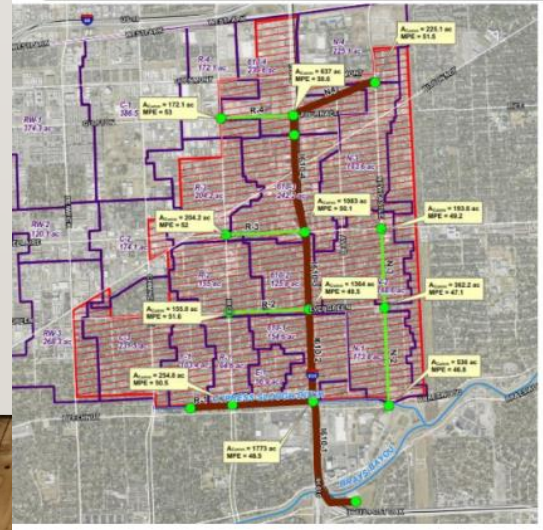
- Mimics topography and locates major systems in lowest portions
- Utilizes Bellaire Blvd to Capture and convey sheetflow from West
- Diverts majority of water from Cypress Ditch improving capacity
- Locates a major systems along railroad track to capture sheetflows

Concept C



- Maintains Existing Drainage Paths
- Upsizing of the existing systems
- Rice System Sized to collect sheetflow from west (Chimney Rock, Renwick)
- Will require improvements to Cypress Ditch

Concept B



- Places Major Collection system along I610 west frontage road where majority of existing sheetflow ponds
- Diverts Rice localize drainage directly to major drainage system
- Keeps east side drainage out of west side of City
- Diverts significant drainage area off of Cypress Ditch
- Utilizes existing HCFCD/COH pond for

https://www.bellairemdcp.com/

BELLAIRE MASTER DRAINAGE CONCEPT PLAN

- 1st step in a larger and more complex planning / engineering effort
- Helps to advance our understanding of flooding in Bellaire and potential solutions
- Helps to inform policy decisions and bracket potential outcomes
- Helps to inform requirements for interlocal partnerships and align for funding
- Provides valuable H&H models which can be used for further study/refinement
- Does not contend to address all flooding challenges in Bellaire
- Does not represent the only solution(s) available to our flooding challenges
- Is based on an assumed desired outcome
- Is based on a series of engineering assumptions and evaluates only select scenarios
- Has not been optimized for economic efficiency
- IT IS UP TO COUNCIL TO DECIDE WHAT TO DO WITH THIS INFORMATION

FLOOD RISK MANAGEMENT OBJECTIVES AND PRIORITIES

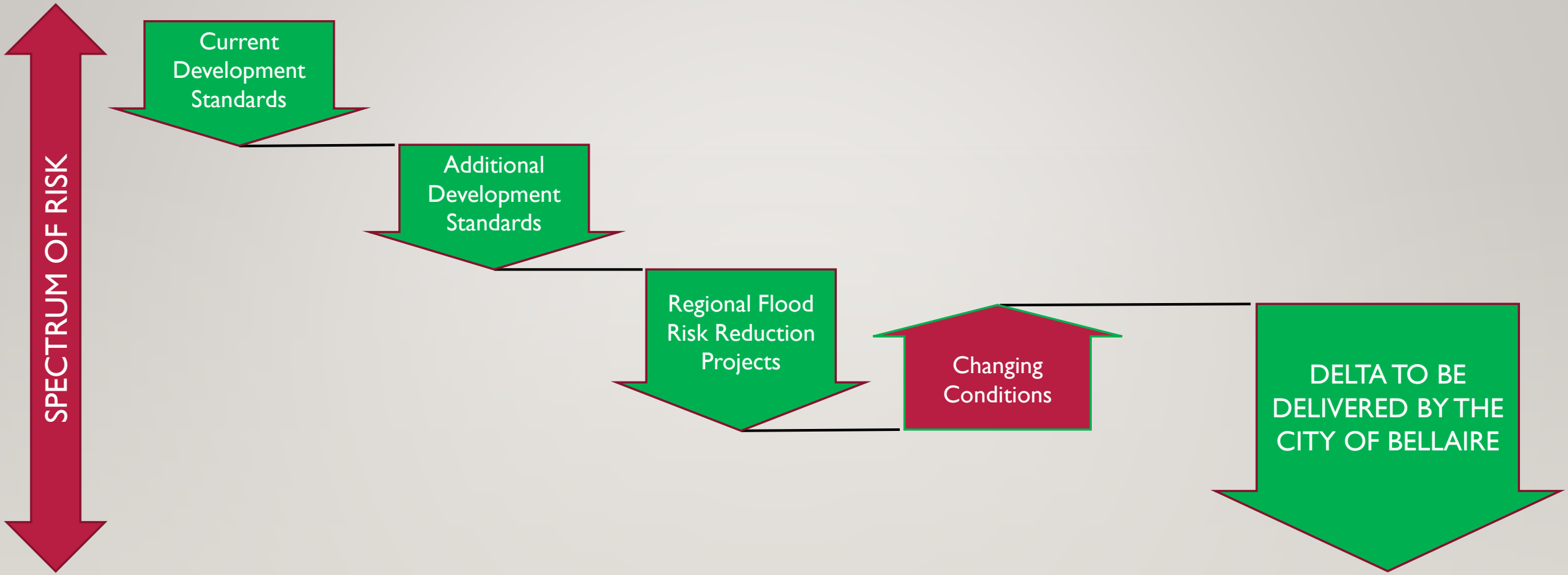
FLOOD RISK MANAGEMENT VS. FLOOD CONTROL

- Cannot 'control' flooding (there are no guarantees)
- We aim to manage risk in order to achieve an acceptable 'risk profile' for Bellaire
- What is the appropriate 'risk profile'? (this informs our design criteria)
  - Acceptable frequency of minor / nuisance flooding?
  - Acceptable frequency of major / structural flooding?
  - Susceptibility to different types of flooding (e.g. fluvial, pluvial)?
- What can we afford? Do the benefits outweigh the costs?
- Holistic Flood Risk Management (recognizing multiple causes of flooding)
  - Local Drainage (streets, storm sewer collectors)
  - Semi-Regional Drainage (major storm sewers, drainage ditches)
  - Regional Drainage (Brays Bayou)
  - Development standards (if it floods, but no one is damaged, do we care?)

THE TASK FOR CITY COUNCIL / CITY STAFF

- Establish consensus objectives for flood risk management
- Determine our acceptable 'risk profile', considering cost (this may be iterative)
- Determine appropriate 'design criteria' for drainage projects
- Develop solutions to achieve acceptable 'risk profile' over a reasonable time frame
  - This is a long-term program of improvements (likely 10 to 20 years)
- Optimize phasing and delivery of solutions
  - Deliver benefits in a timely manner (an in the areas of greatest need first)
  - Delivery projects in the most cost-effective manner
  - Secure outside funding support (regional/state/federal)
- Have to think 'long-term' – our infrastructure is a 50-year investment
- Must act quickly on currently available partnership projects (with cost-share potential)

CURRENT LEVEL OF FLOOD RISK



DESIRED LEVEL OF FLOOD RISK

NEXT STEPS / IMPLEMENTATION PLAN

- Local
- Semi-regional
- Regional
- Development standards and regulations

- Infrastructure renewal
- Core / trunk-line projects
- Special purpose projects

- Grants
- Partnerships
- Low Interest Loans
- Traditional Bonding
- Utility Fees?

"LOW HANGING FRUIT"

Obvious projects we should tackle first, either due to the opportunity for partnership funds, or a project's immediate efficiency in providing benefits, while still supporting our broader strategic goals.

ALIGNING THE CITY FOR ACTION

- City Council to develop flood risk management objectives (April / May)
- City staff to finalize and close out Master Drainage Concept Plan (April / May)
- City staff to select new engineering consultant / flood technical advisor (April / May)
- Next, Staff / Flood Technical Advisor should:
  - Develop and refine drainage design criteria
  - Advance "low hanging fruit" projects
  - Secure partnerships / funding to deliver the "low hanging fruit" projects
  - Create long-term capital improvement plan to achieve broader drainage objectives
  - Pursue outside funding / partnerships to cover as much of the costs as is possible
  - Advance engineering / development of the initial phases of the capital improvement plan
  - Align funding for the timely delivery of the initial and subsequent phases of the plan

FURTHER DISCUSSION