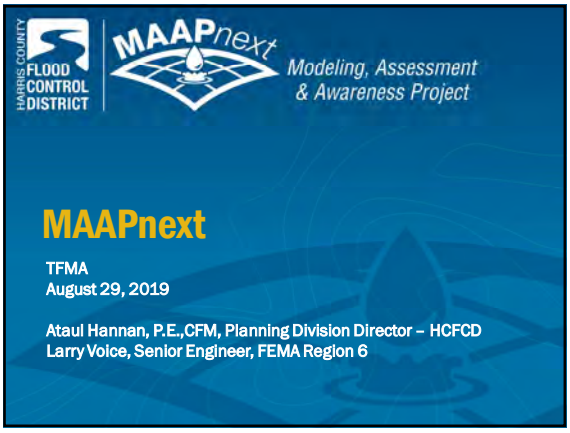
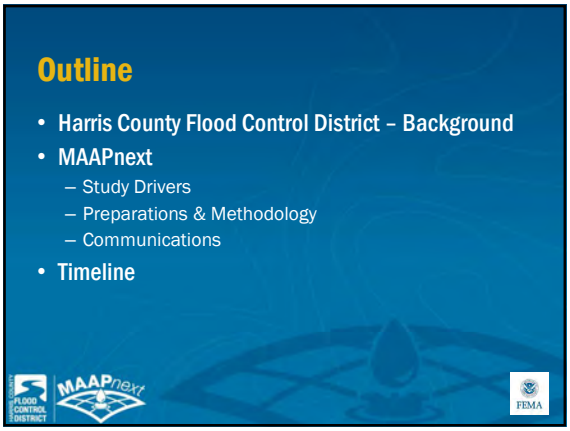
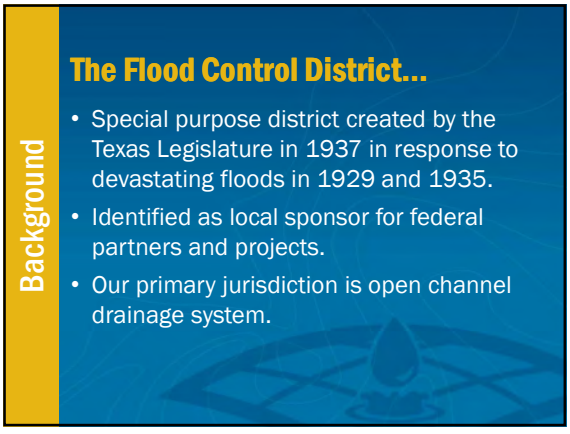

HARRIS COUNTY FLOOD CONTROL DISTRICT
MAAPnext
Modeling, Assessment & Awareness Project
MAAPnext
TFMA
August 29, 2019
Ataul Hannan, P.E.,CFM, Planning Division Director – HCFCD
Larry Voice, Senior Engineer, FEMA Region 6

1

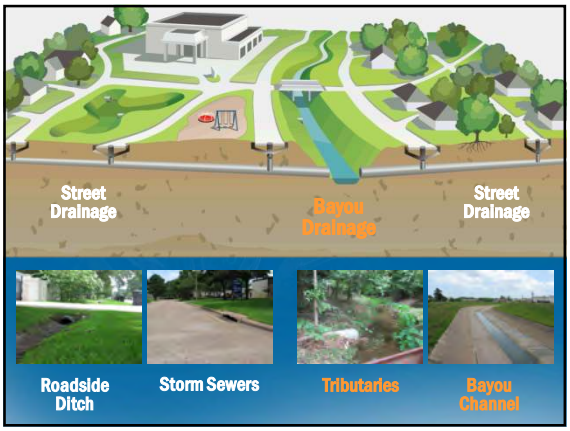

Outline
• Harris County Flood Control District – Background
• MAAPnext
– Study Drivers
– Preparations & Methodology
– Communications
• Timeline
FEMA

2

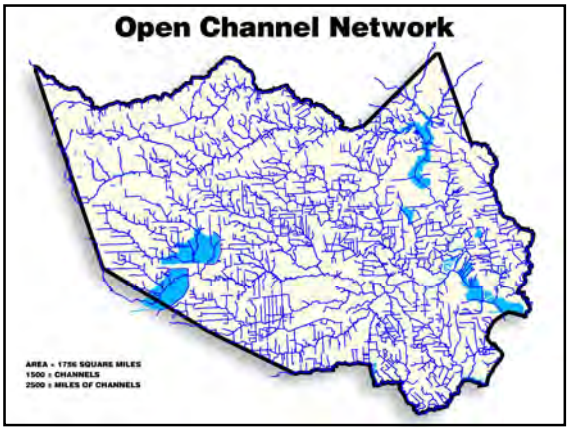

Background
The Flood Control District…
• Special purpose district created by the Texas Legislature in 1937 in response to devastating floods in 1929 and 1935.
• Identified as local sponsor for federal partners and projects.
• Our primary jurisdiction is open channel drainage system.

3

4

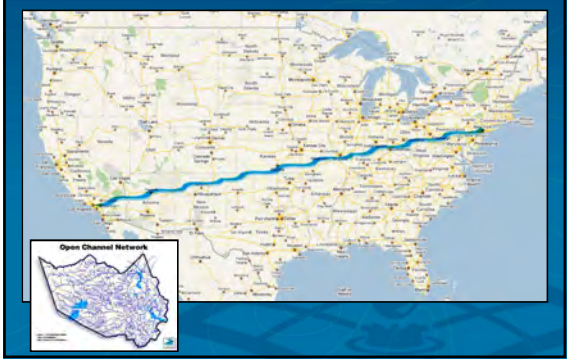

Street Drainage
Bayou Drainage
Street Drainage
Roadside Ditch
Storm Sewers
Tributaries
Bayou Channel

5


Open Channel Network
AREA = 1756 SQUARE MILES
1500 ± CHANNELS
2500 ± MILES OF CHANNELS

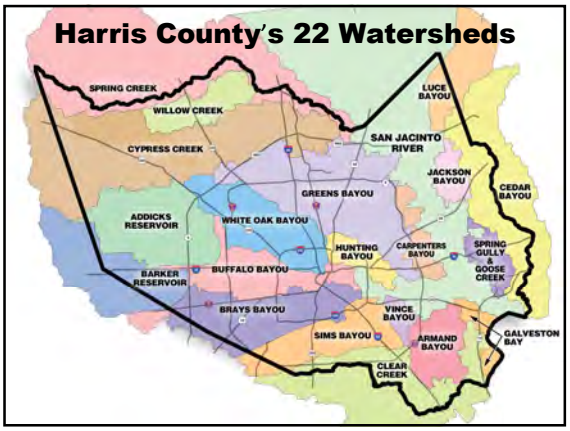
6

2,500 Miles: Los Angeles to New York



7

Harris County's 22 Watersheds



8

Background

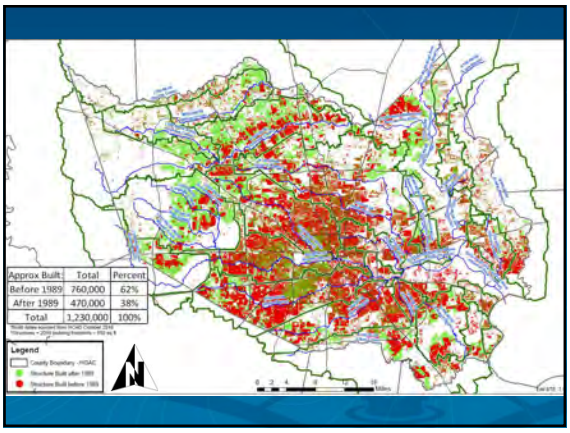
Why we flood:

- Prone to severe rainfall, tropical storms, and hurricanes
- Flat topography
- Impermeable clay soils

"The surface of the entire region is very level and even, with a descent to the coast so gradual as to afford no drainage to the soils, and, as a natural consequence, water remains in pools upon prairies…until removed by evaporation.

R.H. Loughridge, 1836
Report on the Cotton Production of the State of Texas

9



10

Background

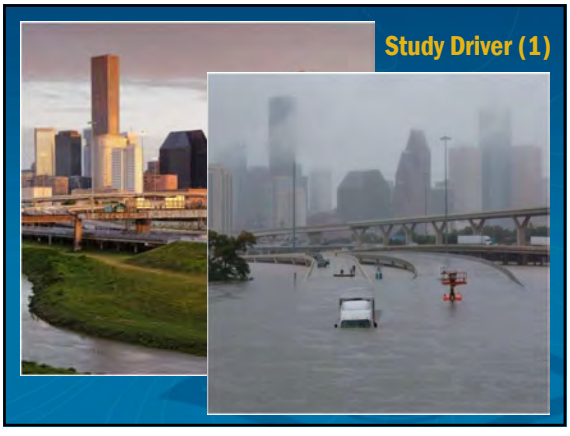
An inherited issue…

Prior to floodplain regulations being defined & implemented in 1980s:

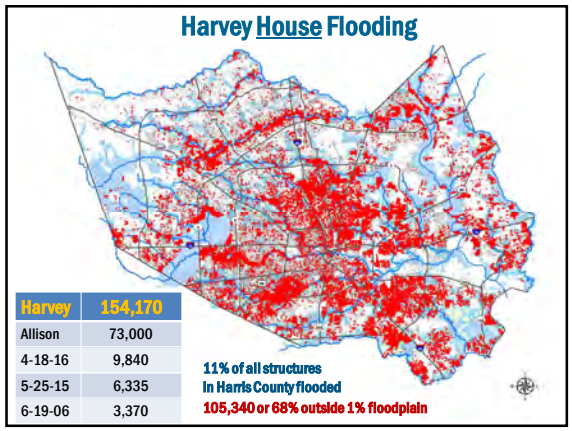
- More than 60% of the county was developed
- More than 5 million people in the area

- Many homes and businesses were built prior to the delineation of a floodplain on a map.
- Flood risk and potential was not widely known or understood.

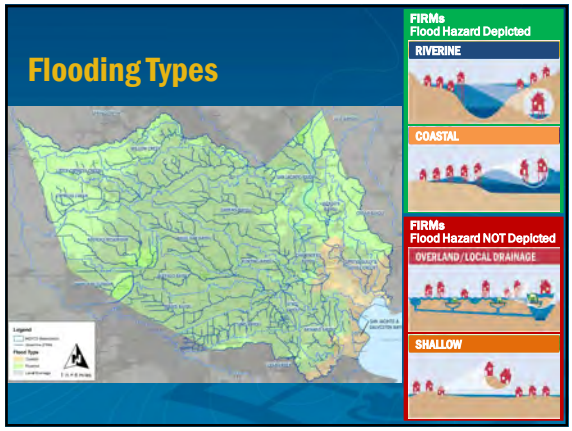
11



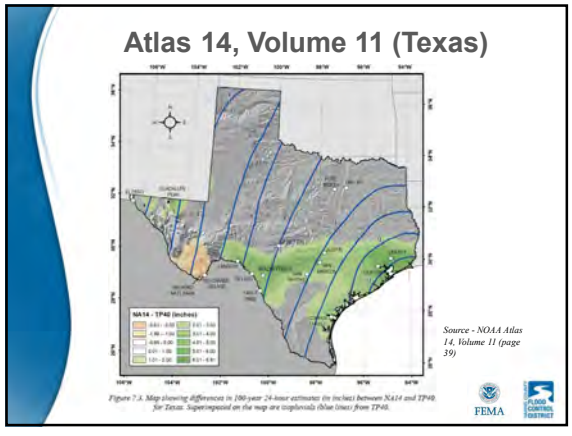
12


Harvey House Flooding
Harvey 154,170
Allison 73,000
4-18-16 9,840
5-25-15 6,335
6-19-06 3,370
11% of all structures
in Harris County flooded
105,340 or 68% outside 1% floodplain

13


Flooding Types
FIRMs
Flood Hazard Depicted
RIVERINE
COASTAL
FIRMs
Flood Hazard NOT Depicted
OVERLAND/LOCAL DRAINAGE
SHALLOW

14


Atlas 14, Volume 11 (Texas)
Source - NOAA Atlas 14, Volume 11 (page 39)
FEMA

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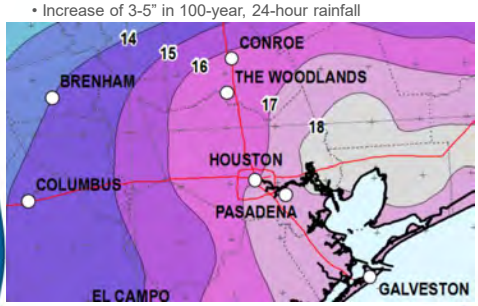
Atlas 14, Volume 11 (Texas)

- Increase of 3-5" in 100-year, 24-hour rainfall



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HCFCD Rainfall Regions - 2002

Region	2-YR Rainfall (inches)	100-YR Rainfall (inches)
1	4.1	12.4
2	4.4	13.2
3	4.5	13.5

FEMA

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HCFCD Rainfall Regions - 2019

Region	2-YR Rainfall (inches)	100-YR Rainfall (inches)
I	4.8	16.3
II	5.1	16.9
III	5.3	18.0

FEMA

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Study Driver (2)

- NOAA Atlas 14

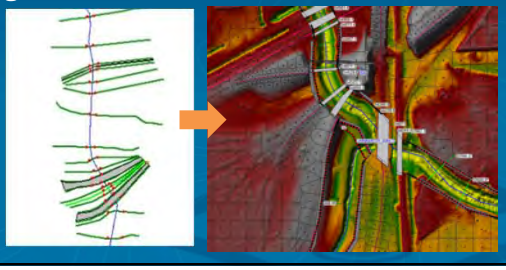
Rainfall increase of about 30% in 1% annual chance event for 24-hour storm

	24-Hr Totals (Inches) 100-Year			24-Hr Totals (Inches - AMS) 500-Year		
Region	Current	Atlas 14	% change	Current	Atlas 14	% change
1	12.4	16.3	31.5%	17.7	24.2	36.7%
2	13.2	16.9	28.0%	18.9	25.0	32.3%
3	13.5	18.0	33.3%	19.3	27.2	40.9%

19

Study Driver (3)

Access to better methodologies and more granular data



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Our Response

- Harris County Floodplain Regulations
  - All new construction in SFHA (1%) to be built 24" above 0.2% (500yr) elevation
  - Locally approved 12/05/2017
  - New code effective 01/01/2018
- HCFCD Criteria Updates
  - Add 2-yr storm evaluation
  - Freeboard requirement
  - 500-yr evaluation for extreme event
  - Higher minimum detention rates (+/- 20%)
  - Preservation of assumed future 1% floodplain by mitigating fill in current 0.2% floodplain
- Voters approve $2.5 Billion bond program

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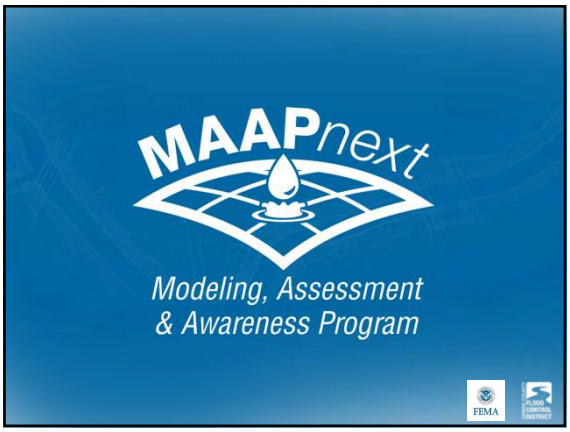

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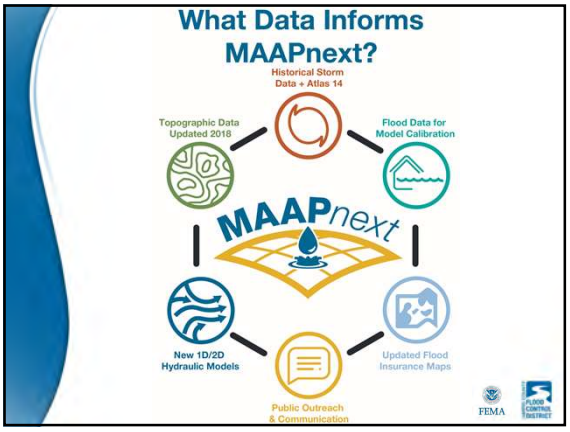
MAAPnext Goals

- **Empower county residents** with flood risk information and education.
- **Lead the nation** in delivering innovative and reliable floodplain mapping and flood risk analysis.
- **Equip Harris County** with up-to-date, comprehensive floodplain mapping and flood risk tools.

23



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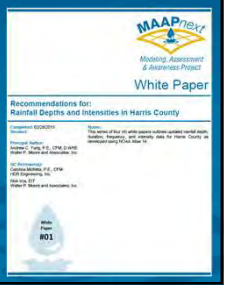
Roles and Responsibilities

25

Preparations for MAAPnext

- Started January 2018
- Methodologies and procedures explored & tested
- Results – 12 White Papers + Hydrology & Hydraulics Methodology Guidance



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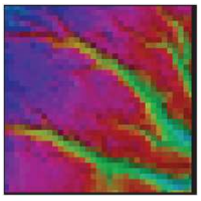
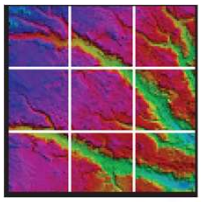
Updates – LiDAR / DEM

2001 DEM
9-Foot Resolution



2018 DEM
3-Foot Resolution



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Challenges & Approaches

Hydrology Inputs

- NOAA Atlas 14
  Texas release 09/2018
- Increases for estimated 24 hour rainfall
  3-4" across Harris County

Urban Environment & Hydrology

Urbanization of Basin
- Basin Development Factor

Ponding/Shallow Flood
- Rain on Grid

Flood Elevation & Extent

- Unsteady State Model
  (FEMA exception – SID73)
- Coupled 1D-2D Model
  (FEMA exception – SID73)
  Main Channel – 1D
  Floodplains – 2D
- Floodway Delineation with Product Number
  (velocity and depth)
  (FEMA exception – SID69)
  (FEMA exception – SID72)

Support Local Floodplain Management

- Defend Floodway Areas
  Floodway is safety based
  Floodway maintains critical flood capacity/storage areas
- Existing Local Higher Standards
  No Adverse Impact review will have access to data
  Harder for fill placement in critical floodplain storage

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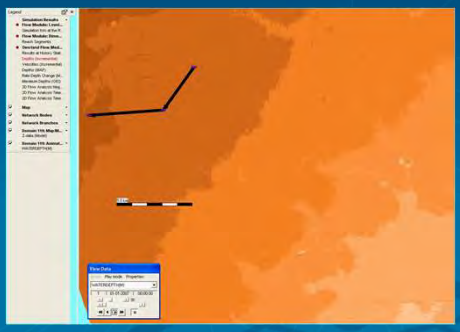
Rain on Grid



29

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Basin Development Factor (BFD)

USGS (1983)

- **A measure of the extent to which a given watershed has been urbanized.**
- **Measures effectiveness of urban drainage systems** (pipes, channels, swales, etc.)

- BDF ranges from 0 to 12.
  0 – completely undeveloped
  12 – fully "improved" w/ drainage
- BDF does NOT directly account for impervious cover
- BDF may be paired with other hydrologic parameters to compute peak runoff rates, time to peak, etc.

HARRIS COUNTY FLOOD CONTROL DISTRICT

FEMA

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Quantifying/Calculating BDF

- Each basin reviewed to evaluate 4 urbanization indicators
  - Channel Improvement (CI)
  - Channel Lining (CL)
  - Storm Sewer (SS)
  - Curb and Gutter Streets (CG)
- Each of is assigned a maximum value of 3 points

Each watershed/basin is evaluated to determine:

- percentage of total stream mileage
- percentage of total drainage area

BDF = %CI(3) + %CL(3) + %SS(3) + %CG (3)

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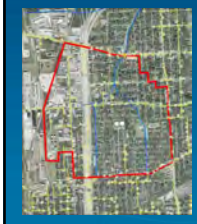
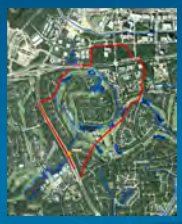
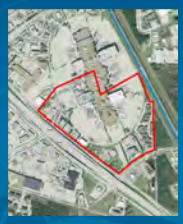
Variation of Basin Development Factor



BDF = 4



BDF = 8



BDF = 12

BDF is not a function of impervious cover; it varies with drainage system improvements.

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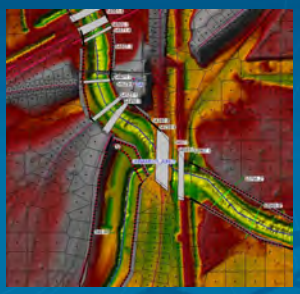
Hydraulics

The Floodway Challenge



- Unsteady, coupled model will allow HCFCD to best detail flood hazards
  - 1D for channel/bridge/culvert
  - 2D overbank flow areas
  - Unsteady analysis will still result in determination of peak flows
- This approach will NOT support traditional floodway encroachment methodology

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Regulatory Floodway 44 CFR 59.1

... the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

Objective:
Identify the area required to convey the Base Flood discharge without increasing the BFE*

**dependent on local ordinance, no more than 1.0 foot*

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Understanding a Floodway

- Concept is difficult to grasp by local decision makers and technical staff
- Various updated and projects adjusting the floodway are received
- Graphics and definitions currently revolve around an imaginary line indicating a limit of fill
- Contrasts the desire to SUSTAIN the conveyance area and RESTRICT development and fill that would reduce the area available to flow

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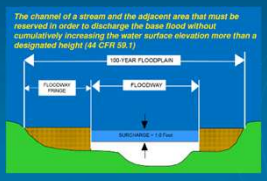
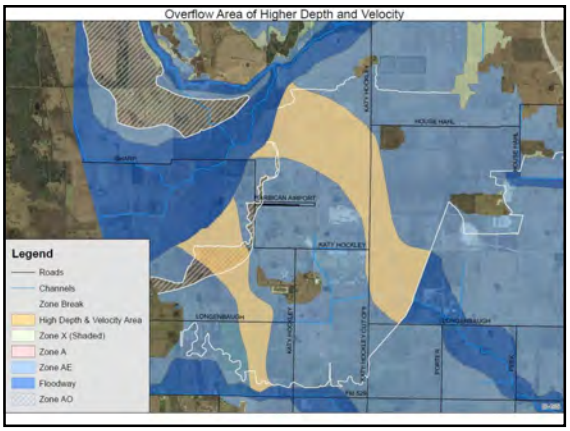
Floodway Challenges (1D/2D)



- Encroachments reduce conveyance AND storage → cause flow increases
- Floodway runs would not be based on the same flows as the 1% annual chance "natural" model
- Targeting 1.0-foot surcharge require numerous iterations – not cost effective
  - A number of local communities have regulations with no adverse impact requirements.

36



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Depth x Velocity Risk Studies

Boulder, Colorado and the U.S. Bureau of Reclamation studies in the 1989s were undertaken to determine the risk of harm for different Depth times Velocity product numbers.

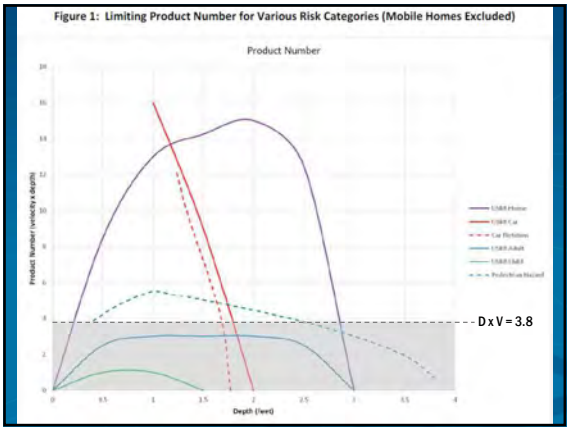
- Risk to structures on foundations
- Risk to mobile home structures
- Risk of car flotation
- Risk to adult pedestrians
- Risk to child pedestrians

Car Floatation Analysis, Simons, Li & Associates, Inc., prepared for City of Boulder, 1984

Analysis of High Hazard Flood Zone, David J. Love & Associated, Inc, prepared for the City of Boulder, 1987

Downstream Hazard Classification Guidelines (ACER Technical Memo No. 11), US Bureau of Reclamation, 1988

38



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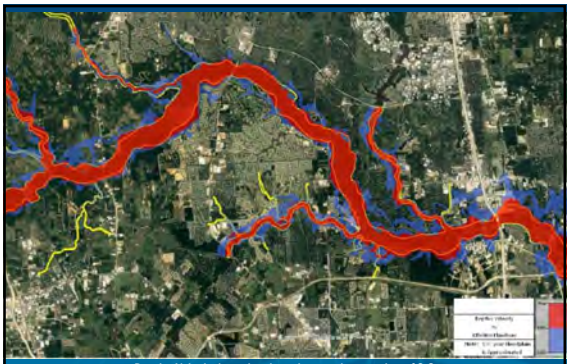
Proposed Approach

A Product Number equal to depth of water times flow velocity (D x V) be used to define an adequate boundary for the floodway

- A product number of 3.8 made physical sense with regard to risk related to the force of water, and produced similar boundaries to the existing floodways
- Harris County already requires that projects have No Adverse Impact (no-rise) to BFEs

40

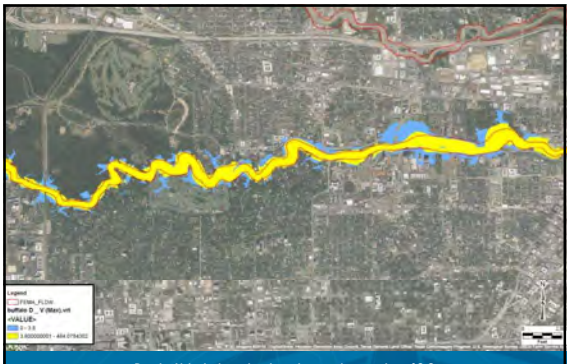


Depth x Velocity boundary based on product number of 3.8

(average sample data from *Analysis of a High Hazard Flood Zone*, David J Love & Associates, 1987)

Red is Product Number > 3.8, Blue is Floodplain < 3.8, Yellow is current Floodway

41

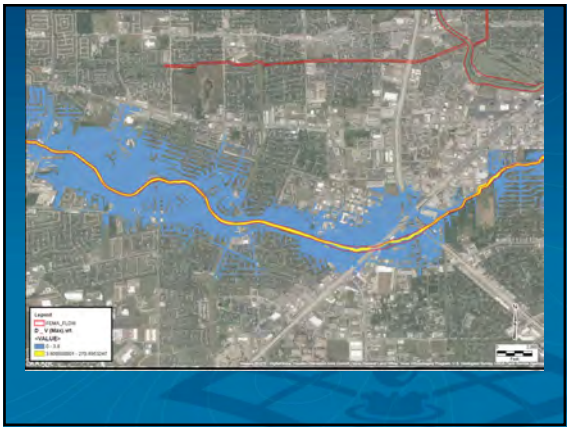


Depth x Velocity boundary based on product number of 3.8

(average sample data from *Analysis of a High Hazard Flood Zone*, David J Love & Associates, 1987)

Yellow is Product Number > 3.8, Blue is Floodplain < 3.8, Red is current Floodway

42



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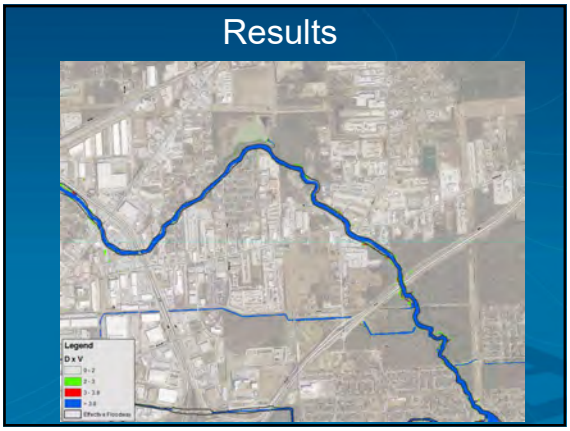
Results



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Results

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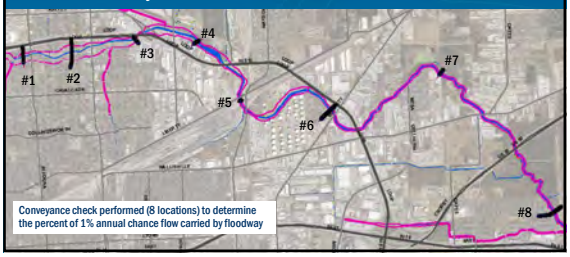
Validation - Conveyance Checks

1. Draw cross section(s)
2. Export to GIS
3. "Extract by Mask"
4. "Raster to Points"
5. Sort & Verify in Excel



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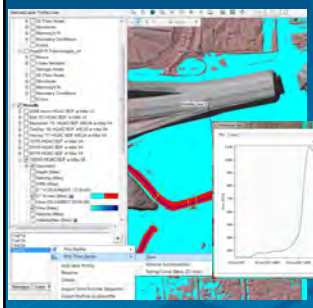
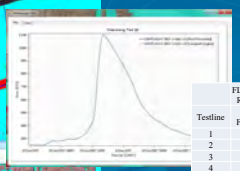
Manual Flow Check



- Draw profile lines across floodplain & across DxV Floodway
- Compare Peak Flows



Testline	FLOW as Measured in RAS Mapper (CFS) All Floodplain	D*V^3	% of flow in D*V ^3
1	519	492.2	94.6%
2	1168	1104	94.2%
3	1346	1239	91.4%
4	1550	1448	93.0%
5	2192	2130	97.1%
6	2895	2840	98.1%
7	3296	3295	100.0%
8	3846	3664	95.0%

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Advantages to Proposed Approach

- Product Number – Output of HEC-RAS 5.0.5 model
  - 1D/2D coupled models can produce product number floodways
  - User identifies a TARGET product number
  - 95% cost saving for floodway analysis
- Floodway informed by physical risk to life and property
  - Floodways delineated using updated approach

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MAAPnext Results

- FEMA to release new Countywide FIRMs
- Flood Risk Products
  - Flood Depth Grids
  - Percent Annual Chance Grids
  - Water Surface Elevation Grids
  - Percent 30-year chance Grids
  - Urban Flooding Map

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Roles and Responsibilities

Technical Data & Production Status

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Roles and Responsibilities

Communications

HARRIS COUNTY FLOOD CONTROL DISTRICT

- Status/Findings of Engineering Efforts
- MAAPnext.org website & social media updates
- Interactive viewer & results release to public
- Code/development requirement support
- Technical approach (modeling/floodways)
- Leads all communications related to project/data
- Leads local coordination efforts

FEMA

- Lead for all policy/procedure questions
- Assumes communications lead once prelim FIRMs production is initiated retains through Effective issuance
- Will coordinate all responses with HCFCD

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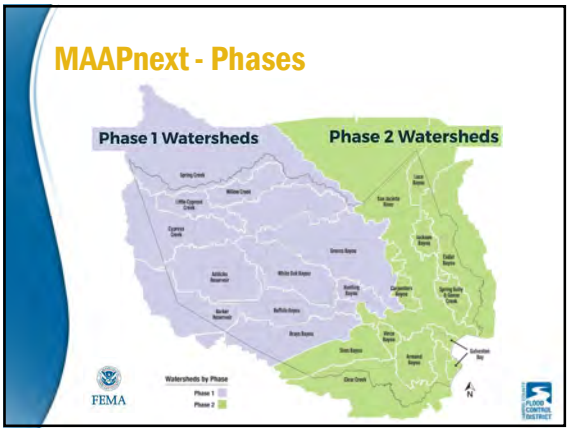
MAAPnext - Phases
Phase 1 Watersheds
Phase 2 Watersheds
FEMA
Watersheds by Phase
Phase 1
Phase 2

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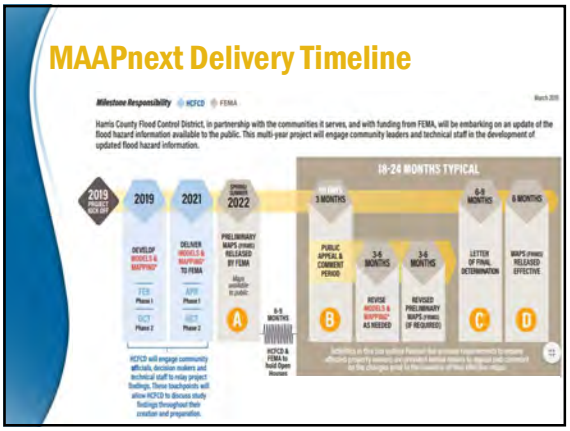
MAAPnext Delivery Timeline
Milestone Responsibility
HCFCD
FEMA
Harris County Flood Control District, in partnership with the communities it serves, and with funding from FEMA, will be embarking on an update of the flood hazard information available to the public. This multi-year project will engage community leaders and technical staff in the development of updated flood hazard information.
18-24 MONTHS TYPICAL
2019
2021
2022
3 MONTHS
6-9 MONTHS
6 MONTHS
PUBLIC APPEAL & COMMENT PERIOD
3-6 MONTHS
3-6 MONTHS
LETTER OF FINAL DETERMINATION
MAPS RELEASED EFFECTIVE
A
B
C
D

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HCFCD leads External Communications
www.maapnext.org
ABOUT MAAPNEXT
IMPROVING OUR DATA
MAAPNEXT RESOURCES
GET IN TOUCH
Floods are powerful,
but knowledge is too.
LET'S MAP A PATH FORWARD
MAAPnext, the Modeling, Assessment and Awareness Project, represents a transformative approach in the management and regulation of Harris County's floodplains, further contributing to our county's resilience.
Get involved
Protect yourself

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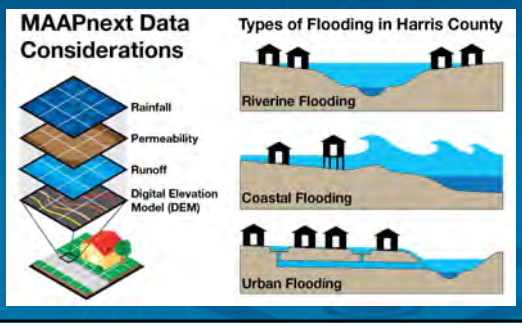
Develop accessible information catering to all key audiences.



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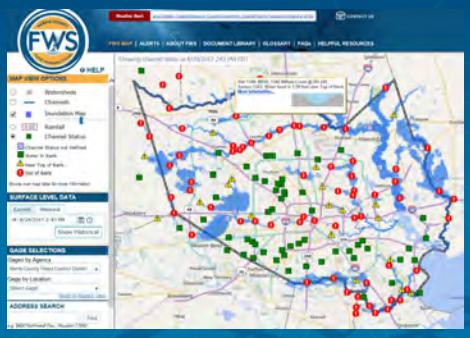
HCFCD



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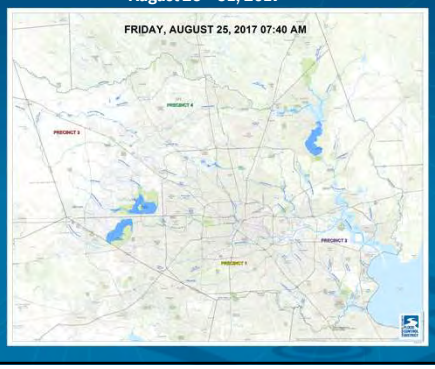
Real time inundation Map for Hurricane Harvey August 25 – 31, 2017



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DRAFT
Estimated Maximum Riverine Inundation
Hurricane Harvey - August 25 - 30, 2017

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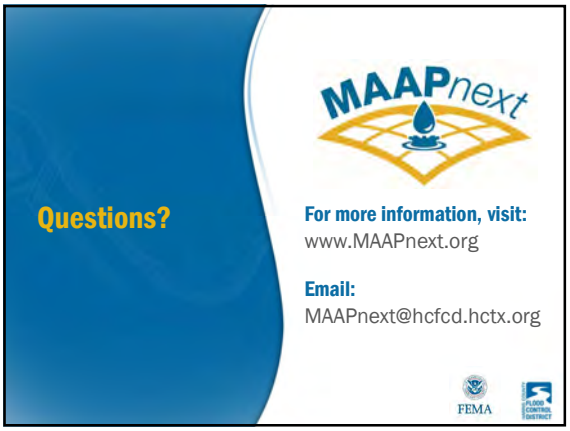
Questions?
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